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CONTENTS:

The committee on Water Service has devoted considerable study during the past two years to the subject of concrete water tanks and presented general plans for the design of these tanks in its report. The American Railway Bridge and Building Association has also gone into this subject, and a very complete report was presented at its convention in St. Louis last October. This latter association very wisely did not attempt to duplicate the work being done by the American Railway Engineering Association, but rather devoted its attention to describing tanks already erected and the service results secured. From the two reports very complete information may be gained concerning recommended design and progress in the use of the reinforced concrete tank. Such tanks have been built in a number of places throughout the country, although in most cases they have been erected as standpipes and storage reservoirs for municipalities rather than as service tanks for railway locomotive water supply. In fact, the adoption of concrete for the latter purpose has been very limited, the Pennsylvania having recently erected in Ohio one of the few concrete tanks built to date. While the reinforced concrete tank has, by the very nature of its construction, a number of marked disadvantages for general railway service, it will doubtless be found of advantage under certain limited applications, and its use will increase as the construction of the railways becomes more permanent.

Mr. Howard's discussion on Rail Specifications seemed to discredit the drop tests as insufficient and furnishing but a very limited indication of the resistance of the material. The test is made under favorable conditions, as the outer fibres are under maximum stress, while in the rail in service the cold rolled effect may cause greater stresses in the interior of the section. It is probable that the most useful function of the drop test will be found in the opportunity to inspect the fracture and discover whether the rail is made of sound steel, and the new specification is valuable in providing for the testing to destruction under the drop, so that the fracture may be inspected. It remains to be seen whether this feature of the specification will be acceptable to the manufacturers for rails at the standard price. So many tensile tests of rail steel have been made that the relation between carbon content, ultimate strength and elastic limit have been fairly well established, and this information could be applied to drop tests of steel of various carbon contents, so that, as Mr. Churchill remarked, "we may soon be able to predicate the chemical contents from the drop test."

The importance of the work of the committee on Electricity in studying the subject of third-rail clearances and in preparing standard clearance lines for equipment and structures should be fully realized. It is most advisable that equipment and track structures be standardized in the early stages of the development of heavy electric traction, which is certain to go forward very rapidly within the next few years. Any delay in adopting such standards now will cause heavy expenses for reconstruction later. The problems connected with the operation of electrified steam lines, or of electric feeders of steam railways, are different from those of an independent interurban line, because a large part of the business must necessarily be interchanged between lines which are partly steam and partly electric. The relation between steam and electric roads is growing closer each year. Steam roads now operate a considerable mileage of electric lines as feeders for both passenger and freight traffic. The New Haven electric lines in New England are the largest development of this kind, while the Southern Pacific's network of electric lines about Los Angeles is also important. Another type of line which will increase rapidly is the main line, which will be electrified for all classes of service. The longest main line electrified for all classes of service is that of the New Haven, extending from New York to Stamford, Conn., a distance of about 35 miles. This company recently has announced that electric operation is to be extended to New Haven, a further distance of 35 miles. Another phase of this electric development is the increasing tendency toward the interchange of freight and passenger traffic between steam and interurban electric lines. A number of important interurban lines are now exchanging traffic regularly with steam lines. All these examples indicate the necessity of providing such standard clearances that the equipment of any road may be freely operated over another road.

COMMITTEE WORK.

The successful prosecution of committee work is essential to the welfare of any technical organization. Strength of such an organization is very largely measured by the quality of the work done by the various committees. From the detailed nature of the investigations undertaken it is necessary for the different committees to go carefully into the various phases of the subjects assigned them to the exclusion of all other subjects. With proper committee work the committeemen become specialists, and their reports become invaluable sources of information to the membership at large. Furthermore, continued service on one committee from year to year, as is the case with many members of the American Railway Engineering Association, is of mutual value to the committee members and to the association.

Committee reports may roughly be divided into two classes, those submitted as information and those embodying definite recommendations evolved from definite study. Most committee reports are too apt to be of the former class. A large number of studies must necessarily be based on the replies received from circular letters asking for the practice of different roads upon a certain subject in order to base satisfactory conclusions on them. From the standpoint of the committee, the easiest way to handle such material is to present replies to this letter at length in a report and allow the reader to draw his own conclusion. To a certain extent this is fully justified. However, the committee are better able to summarize the results and give the proper weight to the different reports than the individual members. Furthermore, without making a detailed study, the average member will become confused by the apparent conflict in the data and ideas presented. The most effective and valuable committee work can be done by boiling down the reports and drawing the conclusions which the information justifies. Being a busy man, the average member of the association desires to know the results, and is not willing to spend the time to conduct his own investigation. Rather, the object of committee work should be to save him this labor.

For these reasons, the action of the board of direction in limiting the scope of individual committee reports this year to two subjects and concentrating attention on them is wise. The board went a step further and requested that the report be boiled down more than has been the case in some previous instances, so that the summary might be presented concisely and clearly without sacrificing any of the material. A number of reports this year show a decided improvement over those of previous years. Because a report is short is not an indication that a committee has done but little work. Brevity frequently indicates more laborious and conscientious work in arranging the essential facts in a report than prolixity. A distinguished newspaper editor used to say to his subordinates: "If you are in a hurry, write a column; if you have plenty of time, write a paragraph."

The limiting of a report to two subjects also tends to improve the work on these subjects. It has frequently been the case that committee work has been diffused over a wide area to the resulting detriment of the entire report. The general subjects on which a great amount of information is readily available have been largely covered, and the work of the association in the future will be a more detailed investigation of matters requiring extended and minute studies. Such studies will necessitate a large amount of individual work on the part of committees in proportion to the number of subjects covered in the reports, but such investigations are even more important than those pertaining to subjects the information regarding which is readily at hand. The work of the committees on Rail, Economics of Location, Electricity, etc., are indicative of what the committee work of the future should, and doubtless will, be.

UNIONISM AND MAINTENANCE OF WAY LABOR.

The paper by Mr. Loree on Labor Unionism, which was read for him by George H. Burgess, at the dinner of the American Railway Engineering Association last night, was one of the most instructive, scholarly and timely addresses ever heard by the members of this association. Probably Mr. Loree somewhat magnified the faults and minimized the virtues of labor unionism; but with this qualification it may be said with confidence that the views expressed by him will receive the approval of most students of the labor problem. There is nothing intrinsically objectionable in the organization of labor, and in efforts by it through its organizations to secure reasonable wages and conditions of employment. On the other hand, it is true that many unions have used, and often still use, methods for attaining their ends that are both illegal and immoral, which deserve condemnation by every good citizen, and which society must suppress for its own protection.

Probably the most interesting feature of Mr. Loree's paper to railway men, and particularly to engineering and maintenance officers, is the concluding part, in which he calls attention to the failure of the Railway Engineering Association to give adequate attention in past years to the labor problem, and urges that to the present list of regular committees there be added a committee on Maintenance of Way Labor "whose duties shall be to investigate the conditions of employment of and the relation of maintenance of way labor to seasonal supply and demand; to consider questions of economy, organization, discipline and equipment of forces for various kinds of work and such other questions as shall from time to time be assigned by the usual authority." Engineering and maintenance officers have a peculiar opportunity to make investigations and adopt measures regarding the wages and conditions of employment of labor which will be beneficial alike to the employees and the railways. The labor employed in track work is organized to a less degree now than any other large body of labor on railways. Employees concerned in the handling of trains have very strong brotherhoods and make many demands and indulge in much conduct of which operating officers complain. There is a tendency toward organization of track employees, and every once in a while there is a strike of such employees somewhere because of refusal of the railways to recognize organizations of them and accede to their demands. Any railway man who does not see that in a comparatively short time the track employees will organize and employ the same methods that are used by the train employees, unless the railways adopt measures which will make it to their interest not to do so, is simply closing his eyes to the facts. Up to this time most roads have done almost nothing to prevent the spread of unionism among maintenance of way employees except to fight it wherever it has appeared. In the long run this method will prove ineffectual unless supplemented by other and better methods.

Aside from their fighting of unionism among track employees wherever it appears, the present policy of most railways in dealing with this class of labor is adapted to encourage its organization. The roads have yielded to the ever recurring importunities and demands of organized employees for increases in wages and easier conditions of employment. At the same time in wages and easier conditions of work they have failed voluntarily to treat their unorganized track employees proportionately well. Furthermore, railway managers have protested against the insistence of organized labor on flat wage scales, and yet have generally followed the policy of fixed flat scales of

wages for track foremen, instead of adopting the policy of systematically basing their wages on the quantity and quality of work done by them individually. It is true that some roads award prizes to maintenance officers and employees for especially good work, but, in the long run, this will not be sufficient to retain their loyalty and prevent them from becoming unionized. Perhaps entire prevention of organization is not desirable, but if the managers regard it as desirable there is but one way for them to accomplish their object, and that is to so treat the unorganized employees as to make them feel that they have little to gain by organizing. By continuing their present policy, the managers are apt to give to employees in the maintenance and engineering department the impression that they have little to lose and much to gain by organization.

In view of existing conditions, it would seem that there can be little serious question as to the wisdom of the recommendation made by Mr. Loree. The Railway Engineering Association ought squarely to face the problem of maintenance of way labor in all of its phases and undertake to deal with it in a just and scientific spirit. No doubt, railway managers think that they have enough labor problems already, and that so far as maintenance labor is concerned it might be a good plan to follow the old adage of "letting sleeping dogs lie." But this policy would be unjust and cowardly, and the railways have often in the past lost a great deal by following a timid policy in dealing with labor questions. They have failed to do justice to some classes of employees simply because these classes have not demanded and insisted upon justice. On the other hand, they have done more than justice to some classes because these have demanded and insisted on having more than justice. In both cases the effect has been to demoralize the labor situation, and, in the long run, to cause loss to the roads.

The Railway Engineering Association and its members individually have a better opportunity to-day to deal intelligently and equitably with labor conditions with a view to securing a maximum increase in efficiency, with a maximum of benefit to both employees and the roads, than any other organization or class of railway officers. Will they take advantage of their opportunity?

PROGRAM.

(Order may be changed by a two-thirds vote of the convention, or by time required for consideration of reports.)

Thursday, March 21.

XVI.	Economics of Railway Location	Bulletin 144
IX.	Signs, Fences and Crossings	Bulletin 144
VI.	Buildings	Bulletin 144
Special.	Grading of Lumber	Bulletins 133, 144
XVII.	Wood Preservation	Bulletin 144
Special.	Uniform General Contract Forms	Bulletin 145
	New Business.	
	Election and Installation of Officers.	
	Adjournment.	

INCREASED AUTOMOBILE SERVICE TO THE COLISEUM.

The National Railway Appliances Association has put in service another automobile to carry convention visitors between the hotel and the exhibit, in addition to the two that were in service on Monday and Tuesday. Instead of the 15-minute schedule that has been observed, an automobile will leave the Armory and the hotel as soon as another arrives.

One of the signal companies exhibiting at the Coliseum has orders for, and work under way on, a total of 800 miles of automatic block signals.

Proceedings.

The Wednesday morning session of the American Railway Engineering Association was called to order at 9:10 o'clock, by President Cushing.

The further consideration of the report of the Committee on Track, carried over from the Tuesday meeting, was taken up.

Discussion on Track.

J. B. Jenkins (B. & O.): No definite action was taken yesterday on conclusion 3. Some question was raised as to the particulars in which the dissenting members of the committee disagreed with the majority. George H. Bremner disagreed, not in regard to the conclusions, except that he wished the conclusions presented merely as representing good practice, instead of for adoption as recommended good practice, but he objected to some portions of the presentation of the facts in connection with the choosing of the number of frogs and length of switch points, evidently taking that part of the report as an argument for the committee's conclusion.

R. O. Rote writes: "I am willing to agree that the report of the committee represents good practice, but I am not willing to agree to a report favoring the raised switch rail for the solid plated frog over a flat switch with a frog on individual tie plates. As you perhaps know, this company uses the flat switch and does not use a single solid plate under ordinary frogs, and, therefore, I do not approve of the findings of this committee in this respect."

G. J. Ray writes: "I am willing, of course, to go on with the committee, assuming that the majority are in favor of the report as submitted. I do not agree, however, with the committee on the recommended length of switch for frogs over No. 14, that is, 33 ft. switch points. I do not believe that the 33 ft. point is in every way practical. Your plan does not indicate how the stock rail joint is to be made or where it is to be placed. Furthermore, I do not see the advantage of a No. 11 over a No. 10 frog for ordinary yard work. You are given permission to sign my name to the report with the understanding that I do not agree with the recommendations referred to above."

I do not think there is any disagreement between Mr. Ray and the rest of the committee regarding the No. 10 and No. 11 frogs for ordinary work. The Lackawanna uses No. 10 almost entirely for yards, while most roads use 7's and 8's and some roads 6's in similar places.

A. Bruner writes: "I subscribe to the committee report, excepting the detail drawings of frogs and switches and frog numbers."

F. S. Stevens writes: "In relation to the report of the Track Committee, I have crossed and marked out such portions of the proposed text as in my opinion should be omitted and have signed a copy and returned it to you by mail."

The portions marked by Mr. Stevens are several slight changes in the reading part of the report which precedes the conclusions, and three paragraphs following "(d) Turnouts requiring frogs of large angle." Mr. Stevens wishes me to omit these three paragraphs as not being a proper portion of the argument. I consider this an introduction rather than an argument for the position of the committee. Mr. Stevens wanted the conclusion in regard to switch points to read 22 ft. points for No. 10 frogs instead of 16½ points. He wanted conclusions No. 1 and 2 to read: "The committee recommends General Specifications, etc., as representing good practice," and "The committee recommends the General Plan, etc., as representing good practice."

The question of 33-ft. switch points has had a great deal of discussion in the committee covering a period of about three years, and the committee is very nearly unanimous that 33-ft. switch points are desirable. At the time the 33-ft. switch point was introduced, I don't think we had any rails rolled longer than 30 ft., and it was not possible to have a stock rail without a joint. Now, with the 33-ft. switch point, we can very readily obtain a 60-ft. stock rail, when it is desired to have a No. 1 track. However, I don't think a 33-ft. stock rail, with a 33-ft. switch point, will make a bad job in main track under fairly high speed if the switch is properly looked after.

J. B. Berry (C. R. I. & P.): This committee was intending to incorporate in the manual the recommendation in regard to frogs and switch points, with five dissenting members. To me that is a very important thing. We, nearly all of us, in times of doubt, go to the manual to see what is best to do, and I know positively that a great many people outside of this association take whatever they find in the manual as the best practice there is and find fault with people who don't use it.

This report says that 55 per cent. of the railways—not of

the mileage—use No. 10 frogs. It says nothing about the length of switches, but 15 ft. is the usual length; so, you see over one-half of the roads in this association are still using a No. 10 frog, with a split switch presumably 15 ft. long. It is justifiable to go to a 16½-ft. split switch and, incidentally, to a No. 11 frog? We can readily see why we go to the shorter split switch in a No. 8 frog, because we have had a great deal of trouble in maintaining a No. 7. You can also understand why it is desirable to use a 30 or 33 ft. switch with a 16-ft. frog, because they are on high-speed lines, but a 14-ft. split switch with No. 10 frog is a different proposition. We have had no trouble maintaining it, and it is simply a question whether, in changing between those two extremes, you will change from No. 10 to No. 11.

Every railway in this association that has from five thousand to ten thousand miles has in stock anywhere from five to ten million dollars' worth of suplies. The storekeepers and the executive officers are continually objecting to getting so many different parts. If a 15-ft. split switch is good enough and a No. 10 frog, why add, even on new work, No. 11? It makes simply so much additional material to carry in stock.

L. S. Rose (C. C. C. & St. L.): This is not a question of safety. The lengths of switches and the numbers of frogs are figured out, we think, on a scientific basis. It is not anything very radical. It will not put anybody in court if we do not adopt it, because it is a question of standards, not of safety. We might have a switch that conformed to these standards that would not be as safe as some switch that did not. It might be a question of the size of the rail or some other detail. Mr. Berry says that we carry large stocks. I submit that the frog and switch stocks change very rapidly on a well-regulated railway. They are worn out. We were instructed to give a recommendation for three lengths of switches, for three lengths of frogs, in order to keep the stock down. If a road adopted this recommendation there would be only three to carry and that would take care of all needs. We tried to give four, but the convention said, "No, only three."

I further think that we have the best three. We can take care of junctions the best that anyone can take of them, up to our present art. We might change our plan, on switches a little; might have curved switches, but we don't think we are up to that yet. The roads don't want to carry so many different kinds in stock. They want a switch that they can use anywhere.

Mr. Bremner: This report was very carefully considered by the committee, and I think the chairman is to be congratulated that he got as near a unanimous opinion from the committee as he has. There is no dissent in the committee, as I understand it, from the fact that the practice recommended in these conclusions is good practice. Conclusion No. 1 is almost unanimously agreed to. In the other two conclusions there is considerable difference of opinion, and a number of members of the committee do not agree that this is the best practice, although they all agree that it is good practice.

In regard to the question of the number of frogs to be submitted as the best practice, it is very questionable whether a No. 8, a No. 11 and a No. 15 will fulfil all conditions. I doubt if there is more than two or three roads in the country that have frogs of these numbers as their standard, not but what many roads have some of them as standards, but the combination as presented by the committee will probably change the practice of nearly every road of the United States to some extent. I am inclined to think that by a full study of the situation on the various roads, a combination of frog numbers could be adopted which would only change a part of the practice. The No. 15 frog, for instance, is not the only frog that is used for terminals. Some roads use 20, some roads use 24 or possibly 22, and frogs lower than No. 8 are very common; in fact, they are general in a yard where it is necessary to save room and where the work is all done by switch engines, so that the limits prescribed by the numbers of the frogs submitted is inside of what is today good practice and may be the best practice. Frogs are constantly becoming sharper, as you know, on account of the high speed, stiffer engines and longer equipment, so that where today the committee recommends a No. 8, a few years ago they would have recommended a No. 6. Possibly a No. 9 may be better in the very near future, and likewise a No. 15 is likely to be replaced by a No. 20, or even higher frog. The practice is constantly changing and the track material is being improved upon very rapidly at the present time.

In regard to the length of switch points, the points recommended are good practice, but they are not the only good practice, and the same arguments in regard to those lengths will apply that apply to the numbers of the frogs. I doubt if there are very many roads in the United States today that are using 33-ft. switch points to a very great extent, not but what they can be used. I see that the German roads are beginning to use switch points even longer than that. To a large extent they have been trying switch points with a fixed heel. The heel on all of our switch points is pivoted. By the use of this fixed heel they get a curved switch point, which, if it can be properly made, I think is very desirable, and it is very likely to come, if we can find a construction that will make the proper fit for the point against the stock rail. They have a special shaped rail for this switch point, and I see no reason why the practice may not become the practice in this country. The use of a special shaped head, and of hardened steel or toughened steel, for our switch points is surely within the lines of economy, if a proper design can be made by which we can get a curved switch point for high-speed trains. I think it is within the province of this convention to adopt these resolutions, not as recommended practice, but as good practice.

Mr. Jenkins: Two of the dissenting members dissented more from the text of the argument than from anything else; they objected to my introducing matter which weighed against the committee's report. My intention, and I think the wish of a great many members of the committee was to present the full information to the association, so that the subject could have proper consideration, and two of the dissenters were simply dissenting because my argument was not strong enough.

A motion to amend the committee's recommendation to combine the lengths of 22-ft. and 33-ft. switch points into one of 26 ft. was lost.

A vote on the motion to accept the committee's recommendation as to switch points showed 58 in the affirmative and 14 opposed.

A motion to reconsider the question of the number of frogs recommended by the committee for adoption as representing good practice was lost.

Mr. Jenkins: I move that this conclusion be printed in the manual.

The substance of the specifications is practically the same as was considered last year. I move that we consider the specifications as a whole.

C. E. Lindsay (N. Y. C. & H. R.): Under "Bolts," the specifications differ from the specifications previously submitted in omitting the "U. S. Standard." The previous specification required that the bolts must be round and true to size, with the U. S. standard square heads and nuts, and the thread should also be specified.

Mr. Rose: That was done so that we could use a special bolt.

Mr. Lindsay: I think that the word "spring" should be substituted for the word "wing" in the paragraph on "Stops and Hold-downs."

Mr. Jenkins: It may be either "spring rail" or "wing rail," but the committee will accept the suggestion.

Mr. Lindsay: In the table which shows the length A. B. for different lengths of switches, if the planing is figured out in feet per inch, the first one is 1 in. in 16 ft., the second 1 in. in 12 ft. and the remainder 1 in. in 6 2-3 ft. I think for the 16-ft. 6-in. switch, that length of planing would better be longer. I move the substitution of 7 ft. for 5 ft. in the length A. B. for that switch.

Motion carried.

A motion to adopt the specifications as amended was carried.

YARDS AND TERMINALS.

The following subjects were assigned:

(1) Report on typical situation plans of passenger stations, of both through and stub types, with critical analyses of working capacity, and include a review of the different methods of estimating their capacity.

(2) Report on developments in the handling of freight by mechanical means.

(3) Report on developments in the design and operation of hump yards.

(4) Report on typical situation plans for a division engine terminal.

(5) Report on methods of handling baggage, express and mail, at passenger terminals.

The committee was also instructed to consider revision of the manual; if no changes were recommended, to make statement accordingly, and to make concise recommendations for next year's work.

After careful consideration of the present manual, the committee has no recommendation for further changes at the present time.

(1) The sub-committee has accumulated a large amount of data with respect to existing terminals. The subject assigned, however, is so broad and important that it is desirable to continue work on it through another year.

(2) Considerable progress has been made at different points in the development of freight handling by mechanical means since the committee's last report, and during the past year inspection was made of the new Missouri, Kansas & Texas Railway freight handling plant at Broadway Station, St. Louis, Mo., the Baltimore & Ohio Railroad telpher system at Pier No. 8, Locust Point, Baltimore, Md., the power conveyor system in one of the new warehouses of the Texas City Transportation Company, at Galveston, Texas, and of the electric truck system at Dock No. 6, Jersey City, N. J. As nearly all of these systems are practically new and sufficient time has not elapsed since installation to enable all points as to their utility to be definitely determined, both as to economy of operation and practical utility, full report on these systems is held over for future publication.

(3) Additional data on existing hump yards have been secured by the sub-committee, and is held for future report.

(4) typical situation plans for division engine terminal.

In treating this subject, the committee understood its work to be the making of recommendations as to the best arrangement of facilities for the handling of locomotives

C. H. SPENCER,
Chairman Committee on Yards and Terminals.

at terminals rather than specifications for exact designs of the various structures involved excepting as in a general way the characteristics of such structures seem to be more or less suited to the arrangement recommended. It is also understood that the scope of the committee's work does not include the consideration of shop or repair yard locations.

A typical plan or layout was submitted for an engine terminal whose characteristics permit of application equally well to larger or smaller demands practically without limit and without respect to whether the locomotives cared for are all freight or passenger, or in both kinds of service.

A number of plans of recently constructed engine terminals were examined. The best ideas of all were adopted and the manifest errors of at least some of these plans were avoided. It must, of course, be recognized that in any case of actual construction, physical limitations as to space and shape of the ground site will impose more or less modification of the plan recommended, but this will come more generally within the possibility of any given set of conditions than any other typical plan that could be suggested.

In locating an engine terminal, the facilities should be placed with reference to the yards and main line in the most advantageous position possible, that is, so that the distance between the engine terminal and the points where engines begin and end their service shall be a minimum, and so that reverse or conflicting movements shall be avoided as much as practicable.

The idea to be kept in mind is the most direct and convenient, that is, rapid and economical performance of those things required for an engine in its terminal in that sequence which answers all requirements in the order of their urgency. It appears to us that on the arrival of a locomotive at its terminal, the first imperative demand is likely to be for water, and that this demand is likely to be the last when leaving the terminal for service. For this reason the typical plan provides for the location of watering facilities accordingly.

After an incoming engine has been protected by receiving water, the next step appears logically to clean its fires or remove it entirely, according to need, and place the engine as quickly as possible in the engine house where it may be cleaned and the repairs necessary to prepare it for new service may be made. The cinder pit should be located as close as practicable to the engine house and permit at the same time of engines moving off the cinder pit in the normal direction, being switched direct to an outbound track without using or fouling the turntable, as may often be desired.

It appears logical that the process of coaling should be reserved, if practicable, until just before the engine re-enters service in order that it may do so with a maximum supply of fuel, and also because the cleaning or removal of fire on cinder pit, as well as the repairs of the engine tank or other repairs, can be accomplished without the interference that might result from having the tender filled with coal. This reasoning dictates that the location of the coaling station should be primarily to serve the outbound tracks. Inasmuch, however, as it may often occur that incoming engines will require coal, the coaling station should be located as indicated on the typical plan, so that coal may also be taken by an engine on an inbound track.

The trestle type of coal dock may be used if desired, if only two coaling tracks are required, and can be located between the inbound and outbound tracks in the same relative position as shown in the typical plan.

The most convenient and economical arrangement for storing and drying sand is at the coal station, where it may be handled by the same attendants. Sand should ordinarily be delivered to engines passing on the inbound tracks.

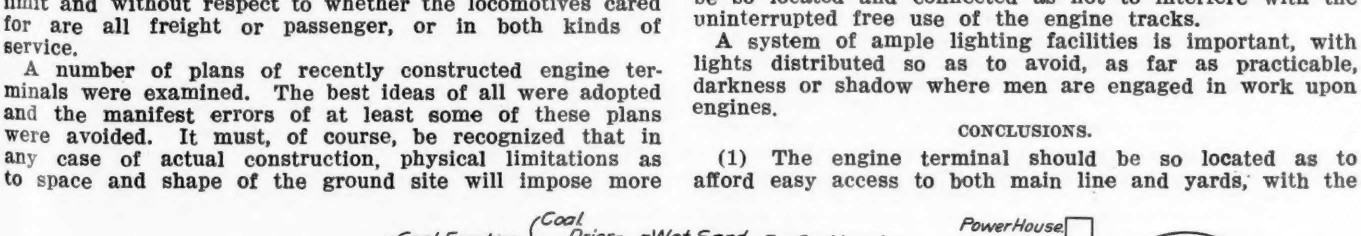
It will be observed that the arrangement of facilities permits of large increase in capacity of cinder pit, coaling station, etc., and in this connection the idea of having the coaling station at a busy terminal comprising two independent units makes a strong appeal for approval in view of the possibility of one of the hoisting plants suffering temporary disability from breakdown, or other cause.

The location of storehouse, oil house and enginemen's tool and locker rooms need not be arbitrarily prescribed, but should be as close as practicable to the engine house and the cinder pit. However, where any of these buildings are served by their own tracks, those tracks should be so located and connected as not to interfere with the uninterrupted free use of the engine tracks.

A system of ample lighting facilities is important, with lights distributed so as to avoid, as far as practicable, darkness or shadow where men are engaged in work upon engines.

CONCLUSIONS.

(1) The engine terminal should be so located as to afford easy access to both main line and yards, with the



Typical Situation Plan for Division Engine Terminal.

fewest possible reverse or conflicting movements.

(2) The facilities provided should be arranged to permit of the most direct and rapid handling of an engine in its terminal in the order of its needs.

The committee recommends for next year's work a continuation of Subjects Nos. 1, 2 and 3, enumerated above.

The report is signed by C. H. Spencer (Washington Terminal), Chairman; E. B. Temple (P. R. R.), Vice-Chairman; Hadley Baldwin (C. C. C. & St. L.), W. C. Barrett (B. & O.), M. S. Blaiklock (G. T.), G. H. Burgess (D. & H.), A. E. Clift (I. C.), A. L. Davis (I. C.), H. T. Douglas, Jr. (W. & L. E.), A. C. Everham (K. C. T.), D. B. Johnston (D. L. W.), H. A. Lane (B. & O.), L. J. McIntyre (N. P.), B. H. Mann (M. P.), A. Montzheimer (E. J. & E.), W. L. Seddon (S. A. L.), A. Swartz (Erie), J. E. Taussig (H. & T. C.), E. E. R. Tratman (Engineering News), W. L. Webb (C. M. & St. P.), J. G. Wishart (C. R. I. & P.).

Discussion on Yards and Terminals.

Conclusion No. 1 was adopted without discussion.

Mr. Lindsay: I agree with Conclusion No. 2 except that it does not state in what order the facilities should be provided for. The committee provides that coal shall be taken when going out. From a motive power standpoint, that is desirable, but from an operating standpoint, and considering the question of time after the engine is ordered, it is desirable to coal an engine coming in, so that there will not be any necessity for its delay after it is ordered in going to its point of departure. The plan does not provide any facility for coaling an engine coming in, and if the plan were modified so that it might be possible to coal the engine coming in or going out, in the same manner that they take water coming in or going out, the conclusion would be much more desirable.

The President: This is simply offered as information and the conclusions need not affect the plan at all.

Mr. Rose: I call attention to the fact that provision is made in the plan for coaling on the inbound track, one track is placed next to the coal port for that purpose.

Mr. Lindsay: Side coaling arrangement?

Mr. Spencer: Yes.

Conclusion No. 2 was adopted.

RAIL.

Reports have been submitted during the year, as a part of the Rail Committee's work as follows:

(A) A Study of Seventeen Good Service Rails, by Robert Trimble and W. C. Cushing, with notes by M. H. Wickhorst. These rails contained carbon within or a little above the usual limit for 85-lb. rails, namely, 0.45 to 0.55. With this carbon the phosphorus was close to 0.10 or above, the manganese was mostly within the usual limits of 0.80 to 1.10. Some of the rails were of fairly uniform composition throughout the section as indicated by the etching, but others were more or less segregated. This study did not perhaps lead to any very definite results, but indicates that under some conditions segregated rails high in phosphorus, and possibly also in carbon, may give long service, although it does not define these conditions either of track or material.

(B and C) Rail Failure Statistics for the Year Ending October 31, 1910, and Segregation and Other Rail Properties as Influenced by the Size of Ingot, by M. H. Wickhorst.

Mr. Cushing made a study of the Rail Failure Statistics and below are his comments on the subject:

(1) Study of these general statistics does not furnish accurate and specific information so as to determine the value of different sections of rail, because:

(a) The conditions of traffic are different.

(b) The conditions of roadbed are different.

(c) The conditions of ingot making and rolling practice are so different that the quality of the material varies widely, and, at the present time, this difference in quality of the material eliminates differences in section; nevertheless, when the time comes that the difference in quality of material will be less, the influence of the section will be more apparent, for there is no doubt that one section is stiffer and stronger than another according to the distribution of the material. Inasmuch as we are endeavoring to eliminate the differences in quality of material and bring it to a high state of perfection, we should not, in the meantime, lose sight of the desirable features of the rail section, but keep them constantly in mind, so that when we arrive at a good quality of metal, we will also have a desirable rail section.

(2) A study of these general statistics tends to disclose unusual results, and were it not for their compilation, we would not have much information relative to the difference between Bessemer and Open-Hearth steel and concerning the various alloys.

(3) The general statistics are also important, in showing a relation between broken rails and failure of head, web and base.

(4) Their tabulation discloses the difference between steel companies when the sections and chemical composition are practically the same.

The report by Mr. Wickhorst covers an investigation made at the South Works of the Illinois Steel Company, to throw light on the relation of the size of ingots of Bessemer rail steel to the segregation of the metalloids, locations of pipes and blow holes, and the properties of the rails. This investigation showed that under the conditions of the tests, the carbon, phosphorus and sulphur collected or segregated toward the interior and upper part of the ingot and that, in a general way, such segregation increased as the size of the ingot increased. The manganese also segregated some, but to a much smaller extent, while the silicon showed little or no tendency to segregate.

The elements which segregated as described also showed a lowering in the top part of the ingot, below the average composition of the steel, and this lowering extended downward along the sides of the ingot. The "negative" segregation increased in general as the size of the ingot increased and also extended down further along the sides of the ingot. There was also a region of negative segregation in the interior and lower part of the ingot, but the lowering of the elements was not as great in this region.

This investigation also indicated that the material was distributed in the rail bar about the same, relatively, as it was in the ingot from which the rail bar had been rolled.

(D) Tests of Rail Steel Ingots and Derivative Shapes Made at Watertown Arsenal, being a review by M. H. Wickhorst of the report published by the Watertown Arsenal.

This report covers a digest and analysis of the government investigation at the Watertown Arsenal of rail steel ingots and derivative shapes as embodied in the Report of Tests of Metals, etc., made at the Watertown Arsenal for the year 1909.

The work indicated that the interior cavities of an ingot cooled directly after pouring are about the same or slightly less than in a similar ingot placed in the soaking pit and then cooled. This same result was also indicated as true of blooms made from such ingots.

It was shown that almost the full tensile strength and ductility of the metal of the lower part of the ingot were obtained by rolling to about one-tenth of the original cross-section, but with the metal of the upper part of the ingot it was necessary to reduce the cross-section to one-twenty-fifth or less of the original amount.

A great many etchings were made and it was shown that the structure of the cross-section as developed by etching varies from the top to the bottom of the ingot and that each structure finds its counterpart in succeeding shapes and at about the same proportionate distance from the top end. It was also shown that the structure was considerably altered by changing the position in which the ingot was allowed to cool, as for instance allowing it to cool on its side after stripping.

(E) Influence of Rolling Temperature on the Properties of Bessemer Rails, by M. H. Wickhorst.

This report covers an investigation made at the works of the Carnegie Steel Company to determine the influence of the temperature of rolling on the properties of Bessemer rails. This work indicated that the ductility and deflection in the drop test were influenced little, if any, by the rolling temperature. The number of blows that it took to break the rails in the drop test was uninfluenced by the temperature of rolling. The yield point and tensile strength in the tension tests were influenced little, if any. The elongation in the tension test decreased some as the temperature increased. The influence of temperature showed most prominently in the tension test, in the reduction of area, which decreased as the temperature of rolling increased. The size of the grain, as shown by the microscope, increased as the temperature increased.

In this report it is also pointed out that the ductility in the drop test with the head of the rail in tension more nearly indicates the ductility of the interior metal as measured in the tension test, than does the ductility in the drop test with the base of the rail in tension, which is usual in inspection work.

Each report mentioned above gives a short summary of the matter contained in it, but the main principles that seem to have been brought out by the year's work are brought out in the brief reviews above.

The general plan of research work during the year has been to direct attention to some one item which enters as a factor in the properties of the finished rail and attempt to obtain definite information concerning its influence by the experimental method of obtaining as great a range as practicable in the one item under consideration, but leaving all other conditions as near alike as obtainable in the several experiments. It is thus hoped to establish in the course of time

the metallurgical principles and laws that apply to the manufacture of steel rails.

The following subjects were assigned for 1911:

(1) Recommend changes in the specifications for steel rails.

Considerable work has been done during the past year in the preparation of specifications, and the specifications submitted herewith are recommended by the committee. Some paragraphs, such as Nos. 5, 6, 14 and 15, are not to be considered as final, it being thought that the committee did not have sufficient information in its possession to make these sections in the specifications mandatory.

One of the sections in question, No. 14, refers to the ductility test. The requirements, in the specifications, for ductility are somewhat lower than some members of the committee think desirable, and it is hoped that sufficient information will be obtained during the coming year to enable the committee to make some revision in these respects.

Paragraph No. 15, referring to deflections as a method of classifying rails, is also tentative. It is the intention when sufficient data is at hand to prescribe maximum and minimum limits for deflections under the drop test.

(2) Present recommendations on standard rail sections.

The committee reports progress.

(3) Continue investigation of the breakage and failure of rails and present summary of conclusions drawn from reports received.

Bulletin No. 137 contains the rail failure statistics for the year ending October 31, 1910, and the conclusions in regard to the matter are presented in that report.

(4) Report on the results obtained from the use of Open-Hearth and Special Alloy steel rails, and the chemical composition of such rails.

Bulletin No. 137, referred to above, containing the report of the rail failure statistics, also gives all the information that the committee has in regard to Open-Hearth and Special Alloy steel rails.

In regard to the remaining part of the outline of work for the year 1911, the committee reports no progress.

The committee desires to call attention to the valuable services rendered by M. H. Wickhorst, engineer of tests for the committee. Mr. Wickhorst has succeeded in winning the confidence of the manufacturers and has thereby succeeded in securing their co-operation in the work which is being done. Considerable light has been thrown upon the subject by these investigations of Mr. Wickhorst, and it is hoped that in the future considerable good will be accomplished as a result of the investigations.

The committee desires to acknowledge the very generous manner in which the various rail manufacturers have offered us the material and facilities of their mills to carry on this research work. The condition of co-operation that we are working under is very gratifying and, it would seem, must work toward the best interests of the railways, the steel mills and the general public.

The committee recommends the following lines for investigation during the coming year:

(1) Recommend changes in specifications for steel rails.

(2) Present recommendations on standard rail sections.

(3) Continue investigation of the breakage and failure of rails and present summary of conclusions drawn from reports received.

(4) Report on the results obtained from the use of Open-Hearth and Special Alloy steel rails, and the chemical composition of such rails.

(5) Present reports on the results of tests made on the various kinds of rail in conjunction with the manufacturers' committee on the revolving machine at South Chicago.

(6) Report on standard drilling for rails.

Special investigations by Mr. Wickhorst.

(1) Test Open-Hearth steel in ingots of various sizes.

(2) Influence of height of ingot with usual cross-section—
  (a) Bessemer steel;
  (b) Open-Hearth steel.

(3) Influence of temperature of rolling on high carbon Open-Hearth steel.

(4) Drop Tests. Influence of temperature of test piece on ductility and deflection in drop test.

(5) Tests with reciprocating machine, especially to determine influence of interior segregation.

(6) Influence of Titanium—
  (a) Bessemer steel;
  (b) Open-Hearth steel.

(8) Influence of methods of cooling on the cooling beds, especially with high carbon steels; also the effects of cold straightening.

(9) Influence of the temperature of the liquid steel when poured into molds.

(10) Experiments with methods of casting ingots for improvements as regards blow holes, pipes, etc.

(11) Drop Tests, Permanent Set, Ductility, etc.
  (a) Influence of carbon.
  (b) Influence of phosphorus.
  (c) Influence of manganese.
  (d) Influence of span of supports.
  (e) Influence of moment of inertia.

The report is signed by Chas. S. Churchill (N. & W.), Chairman; R. Montfort (L. & N.), Vice-Chairman; E. B. Ashby (L. V.), J. A. Atwood, A. S. Baldwin, J. B. Berry, M. L. Byers, W. C. Cushing, F. A. Delano, P. H. Dudley, C. H. Ewing, C. W. Huntington, John D. Isaacs, Thos. H. Johnson, Howard G. Kelley, C. A. Morse, George W. Kittredge, J. T. Richards, J. P. Snow, A. W. Thompson, Robert Trimble, M. H. Wickhorst.

SPECIFICATIONS FOR CARBON STEEL RAILS.

Inspection.

Access to Works.

1. Inspectors representing the purchaser shall have free entry to the works of the manufacturer at all times while the contract is being executed, and shall have all reasonable facilities afforded them by the manufacturer to satisfy them that the rails have been made in accordance with the terms of the specifications.

Place for Tests.

2. All tests and inspections shall be made at the place of manufacture, prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the mill

Material.

Material.

3. The material shall be steel made by the Bessemer or Open-Hearth process provided by the contract.

Chemical Requirements.

Chemical Composition.

4. The chemical composition of the steel from which the rails are rolled, determined as prescribed in Section 7, shall be within the following limits:

	For Bessemer Process		For Open-Hearth Process.	
Elements	70 lbs. and over, but under 85 lbs.	85-100 lbs. inclusive.	70 lbs. and over, but under 85 lbs.	85-100 lbs. inclusive.
Carbon	0.40 to 0.50	0.45 to 0.55	0.53 to 0.66	0.63 to 0.76
Manganese	0.80 to 1.10	0.80 to 1.10	0.60 to 0.90	0.60 to 0.90
Silicon not to exceed	0.20	0.20	0.20	0.20
Phosphorus not to exceed	0.10	0.10	0.04	0.04

Modification of Carbon for Low Phosphorus.

5. When the material used at any mill is such that the average phosphorus content of the ingot metal used in the Bessemer process is running below 0.08 and in the Open-Hearth process is running below 0.03, and if it seems mutually desirable, the carbon may be increased at the rate of 0.035 for each 0.01 that the phosphorus content of the ingot metal used averages below 0.08 for Bessemer steel, or 0.03 for Open-Hearth steel.

Average Carbon.

6. It is desired that the percentage of carbon in an entire order of rails shall average as high as the mean percentage between the upper and lower limits specified.

Analyses.

7. In order to ascertain whether the chemical composition is in accordance with the requirements, analyses shall be furnished as follows:

(a) For Bessemer process the manufacturer shall furnish to the inspector, daily, carbon determinations for each heat before the rails are shipped, and two chemical analyses every twenty-four hours representing the average of the elements, carbon, manganese, silicon, phosphorus and sulphur contained in the steel, one for each day and night turn respectively. These analyses shall be made on drillings taken from the ladle test ingot not less than one-eighth inch beneath the surface.

(b) For Open-Hearth process, the makers shall furnish the inspectors with a chemical analysis of the elements, carbon, manganese, silicon, phosphorus and sulphur, for each heat.

(c) On request of the inspector, the manufacturer shall furnish drillings from the test ingot for check analyses.

Physical Requirements.

Physical Qualities.

8. Tests shall be made to determine:

(a) Ductility or toughness as opposed to brittleness.

(b) Soundness.

Method of Testing.

9. The physical qualities shall be determined by the Drop Test.

Drop Testing Machine.

10. The drop testing machine used shall be the standard of the American Railway Engineering Association.

(a) The tup shall weigh 2,000 lbs., and have a striking face with a radius of 5 in.

(b) The anvil block shall weigh 20,000 lbs., and be supported on springs.

(c) The supports for the test pieces shall be spaced 3 ft. between centers and shall be a part of, and firmly secured to the anvil. The bearing surfaces of the supports shall have a radius of 5 in.

Pieces for Drop Test.

11. Drop tests shall be made on pieces of rail not less than 4 ft. and not more than 6 ft. long. These test pieces shall be cut from the top end of the top rail of the ingot, and marked on the base or head with gage marks 1 in. apart for 3 in. each side of the center of the test piece, for measuring the ductility of the metal.

Temperature of Test Pieces.

12. The temperature of the test pieces shall be between 60 and 100 deg. Fahrenheit.

Height of Drop.

13. The test piece shall, at the option of the inspector, be placed head or base upwards on the supports, and be subjected to impact of the tup falling free from the following heights:

For 70-lb. rail........................16 feet
For 80, 85 and 90 lb. rail.............17 feet
For 100-lb. rail.......................18 feet

Elongation or Ductility.

14. Under these impacts the rail under one or more blows shall show at least 6 per cent. elongation for 1 in., or 5 per cent. each for two consecutive inches of the 6-in. scale, marked as described in Section 11.

Permanent Set.

15. It is desired that the permanent set after one blow under the drop test shall not exceed that in the following table, and a record shall be made of this information.

Rail.			Permanent Set, measured by Middle Ordinate in Inches in a Length of 3 Ft.	
Section.	Weight per Yard.	Moment of Inertia.	Bessemer Process.	O.-H. Process.
A.R.A.-A	100	48.94	1.65	1.45
A.R.A.-B	100	41.30	2.05	1.80
A.R.A.-A	90	38.70	1.90	1.65
A.R.A.-B	90	32.30	2.20	2.00
A.R.A.-A	80	28.80	2.85	2.45
A.R.A.-B	80	25.00	3.15	2.85
A.R.A.-A	70	21.05	3.50	3.10
A.R.A.-B	70	18.60	3.85	3.50

Test to Destruction.

16. The test pieces which do not break under the first or subsequent blows shall be nicked and broken, to determine whether the interior metal is sound.

Bessemer Process Drop Tests.

17. One piece shall be tested from each heat of Bessemer steel.

(a) If the test piece does not break at the first blow and shows the required elongation (Section 14), all of the rails of the heat shall be accepted, provided that the test piece when nicked and broken does not show interior defect.

(b) If the piece breaks at the first blow, or does not show the required elongation (Section 14), or if the test piece shows the required elongation, but when nicked and broken shows interior defect, all of the top rails from that heat shall be rejected.

(c) A second test shall then be made of a test piece selected by the inspector from the top end of any second rail of the same heat, preferably of the same ingot. If the test piece does not break at the first blow, and shows the required elongation (Section 14), all of the remainder of the rails of the heat shall be accepted, provided that the test piece when nicked and broken does not show interior defect.

(d) If the piece breaks at the first blow, or does not show the required elongation (Section 14), or if the piece shows the required elongation but when nicked and broken shows interior defect, all of the second rails from that heat shall be rejected.

(e) A third test shall then be made of a test piece selected by the inspector from the top end of any third rail of the same heat, preferably of the same ingot. If the test piece does not break at the first blow and shows the required elongation (Section 14), all of the remainder of the rails of the heat shall be accepted, provided that the test piece when nicked and broken does not show interior defect.

(f) If the piece breaks at the first blow, or does not show the required elongation (Section 14), or if the piece shows the required elongation, but when nicked and broken shows interior defect, all of the remainder of the rails from that heat shall be rejected.

Open-Hearth Process Drop Tests.

18. Test pieces shall be selected from the second, middle and last full ingot of each Open-Hearth heat.

(a) If two of these test pieces do not break at the first blow and show the required elongation (Section 14), all of the rails of the heat shall be accepted, provided that these test pieces when nicked and broken do not show interior defect.

(b) If two of the test pieces break at the first blow, or do not show the required elongation, or if any of the pieces that have been tested under the drop when nicked and broken show interior defect, all of the top rails from that heat shall be rejected.

(c) Second tests shall then be made from three test pieces selected by the inspector from the top end of any second rails of the same heat, preferably of the same ingots. If two of these test pieces do not break at the first blow and show the required elongation (Section 14), all of the remainder of the rails of the heat shall be accepted, provided that the pieces that have been tested under the drop when nicked and broken do not show interior defect.

(d) If two of these test pieces break at the first blow or do not show the required elongation (Section 14), or if any of the pieces that have been tested under the drop when nicked and broken show interior defect, all of the second rails of the heat shall be rejected.

(e) Third tests shall then be made from three test pieces selected by the inspector from the top end of any third rails of the same heat, preferably of the same ingots. If two of these test pieces do not break at the first blow, and show the required elongation (Section 14), all of the remainder of the rails of the heat shall be accepted, provided that the pieces that have been tested under the drop when nicked and broken do not show interior defect.

(f) If two of these test pieces break at the first blow or do not show the required elongation (Section 14), or if any of the pieces that have been tested under the drop when nicked and broken show interior defect, all of the remainder of the rails from that heat shall be rejected.

No. 1 Rails.

19. No. 1 classification rails shall be free from injurious defects and flaws of all kinds.

No. 2 Rails.

20. (a) Rails, which, by reason of surface imperfections, or for causes mentioned in Section 30 hereof, are not classed as No. 1 rails, will be accepted as No. 2 rails, but No. 2 rails which contain imperfections in such number or of such character as will, in the judgment of the inspector, render them unfit for recognized No. 2 uses, will not be accepted for shipment.

(b) No. 2 rails to the extent of 5 per cent. of the whole order will be received. All rails accepted as No. 2 rails shall have the ends painted white and shall have two prick punch marks on the side of the web near the heat number near the end of the rail, so placed as not to be covered by the splice bars.

Details of Manufacture.

Quality of Manufacture.

21. The entire process of manufacture shall be in accordance with the best current state of the art.

Bled Ingots.

22. Bled ingots shall not be used.

Discard.

23. There shall be sheared from the end of the bloom, formed from the top of the ingot, sufficient metal to secure sound rails.

Lengths.

24. The standard length of rails shall be 33 ft., at a temperature of 60 deg. Fahrenheit. Ten per cent. of the entire order will be accepted in shorter lengths varying by 1 ft. from 32 ft. to 25 ft. A variation of ¼ in. from the specified lengths will be allowed. No. 1 rails less than 33 ft. long shall be painted green on both ends.

Shrinkage.

25. The number of passes and speed of train shall be so regulated that on leaving the rolls at the final pass, the temperature of the rail will not exceed that which requires a shrinkage allowance at the hot saws, for a rail 33 ft. in length and of 100 lbs. section, of 6¾ in. and ⅛ in. less for each 10 lbs. decrease in section.

Cooling.

26. The bars shall not be held for the purpose of reducing their temperature, nor shall any artificial means of cooling

them be used after they leave the finishing pass. Rails, while on the cooling beds, shall be protected from snow and water.

Section.

27. The section of rails shall conform as accurately as possible to the template furnished by the Railway Company. A variation in height of 1/64 in. less or 1/32 in. greater than the specified height, and 1/16 in. in width of flange, will be permitted; but no variation shall be allowed in the dimensions affecting the fit of the splice bars.

Weight.

28. The weight of the rails specified in the order shall be maintained as nearly as possible, after complying with the preceding section. A variation of one-half of 1 per cent. from the calculated weight of section, as applied to an entire order, will be allowed.

Payment.

29. Rails will be accepted and paid for according to actual weights.

Straightening.

30. The hot straightening shall be carefully done, so that gagging under the cold presses will be reduced to a minimum. Any rail coming to the straightening presses showing sharp kinks or greater camber than that indicated by a middle ordinate of 4 in. in 33 ft., for A. R. A. type of sections, or 5 in. for A. S. C. E. type of sections, will be at once classed as a No. 2 rail. The distance between the supports of rails in the straightening presses shall not be less than 42 in. The supports shall have flat surfaces and be out of wind.

Drilling.

31. Circular holes for joint bolts shall be drilled to conform accurately in every respect to the drawing and dimensions furnished by the railway company.

Finishing.

32. (a) All rails shall be smooth on the heads, straight in line and surface, and without any twists, waves or kinks. They shall be sawed square at the ends, a variation of not more than $\frac{1}{32}$ in. being allowed; and burrs shall be carefully removed.

(b) Rails improperly drilled or straightened, or from which the burrs have not been removed, shall be rejected, but may be accepted after being properly finished.

Branding.

33. The name of the manufacturer, the weight and type of rail, and the month and year of manufacture shall be rolled in raised letters and figures on the side of the web. The number of the heat and a letter indicating the portion of the ingot from which the rail was made shall be plainly stamped on the web of each rail, where it will not be covered by the splice bars. The top rails shall be lettered "A," and the succeeding ones "B," "C," "D," etc., consecutively; but in case of a top discard of twenty or more per cent., the letter "A" will be omitted. Open-Hearth rails shall be branded or stamped "O. H." All markings of rails shall be done so effectively that the marks may be read as long as the rails are in service.

Separate Classes.

34. All classes of rails shall be kept separate from each other.

Loading.

35. All rails shall be loaded in the presence of the inspector.

Discussion on Rail.

The President: We have with us at our invitation, James E. Howard, of the Bureau of Standards.

Mr. Howard: The work your committee has in hand is advancing the subject very materially, and so far I think they have succeeded in a highly satisfactory manner.

I never feel like tying myself down very closely to specifications. They are necessary, but not all that is needed. In regard to the influence of ductility, I will take up a few features by reading a few paragraphs in your specifications. As to this question of ductility and the deflections in the drop tests, when we come to analyze the case it seems that the drop test simply gives us an indication of well-worked metal. I do not know that it does very much more. If we have the composition of the steel and know that it was cast in an ingot and reduced 30 or 40, or 50 times, we have good evidence when it reaches the form of a rail that it has been well worked. I do not know that we could secure better evidence that it has been well worked than the fact it has become a rail, so that the drop test, in that respect, merely shows we have secured what we know we have.

In regard to the deflection, what does that mean further than that one ordinate of a stress-strain curve has been determined? If we make a tension test of steel we get its elastic limit, and its stretch is measured at different intervals beyond that point. We are not usually content with just one ordinate. I would raise a question for your consideration, whether the drop test goes quite far enough. We all like to know something about the elastic limit of the material.

That goes right back to the question of what elastic limit is needed in steel rails. Then it comes to the definition of what fiber stresses you have in rails. So far as I am concerned, I do not know what the fiber stresses are. Some of the gentlemen present may give you a better idea of that, but I doubt it. Earlier tests which I had the pleasure of conducting show that the fiber stress varied with different types of engines and different wheels on the same engine, so I feel that in general the specifications and tests have not yet quite touched some of the vital points.

In regard to the extension due to the drop test, we are stretching the metal in the most favorable direction. If we had the same ductility in the crosswise direction that we have longitudinally, I do not think we should see so many base fractures. The crescent-shaped fractures are due to a want of structural soundness, which is very evident when the bases are bent in a crosswise direction, but these defects are not apparent when we stretch the material lengthwise.

As to the question of chemical analyses, the few observations that I have made show that the analyses of the rail in its cross section may vary considerably. One case now before me showed the carbon at the outer portions .44 to .45, which must be a case of bad segregation, you might say, and at the center of the head it was as high as .77. That variation is pretty wide, but do you find in the test ingot very much clue to what actually exists in the rails? Should not the rails now and then be scrutinized in that manner for the purpose of determining whether any parts of the ingot were exposed to segregation, whether the outer portions are not in a measure decarbonized? There are reasons for thinking that there is need for such procedure.

These are the salient features which to me seem desirable to consider, and I thought they might aid us in securing a better material.

The President: Have you any criticism to make on the chemical proposition proposed for these specifications?

Mr. Howard: The chemical composition carries with it the idea of certain physical properties. We have to go right back to the fiber stresses which are involved and until they are defined we cannot reach a definite conclusion; that is, considering the rail as a beam subjected to bending stresses. When it is subjected to wheel pressures, cold rolling on the running surface of the head, that is still another question. It seems that, in general, a lower carbon steel responds very quickly to the cold rolling of the wheel pressures and we do not have a very high fiber stress before the elastic limit is reached. Higher carbon steel than a very mild one is certainly necessary. Then there is danger in going too far lest there should be some brittleness introduced, so that I am inclined to favor a moderate, a medium carbon; I think the zone of safety lies around .65 to .70. You might go a little outside of those limits, but I think that is reasonably safe.

The President: For open hearth, Mr. Howard?

Mr. Howard: For open hearth. I am not prepared to make a distinction between the two grades of steel at the present time.

This feature of ductility is one to be considered and we do know that when a material is subjected to repeated stresses it will fail without the display of any ductility whatever. Now, if we have a very low carbon steel, with great ductility at the outset, when subjected to a low fiber stress, in alternate directions, it very quickly reaches a brittle condition. That metal will fail without any display of ductility, and the hardest steel cannot do any less, so that we must have considerable stiffness or strength in the material to resist the bending stresses. The ductility which you find in the drop test is inherent to the new material and not to that material which has been repeatedly strained. The overstraining force may not ordinarily reach the elastic limit of the material, when this final state of brittleness is introduced. If the metal is a strong one, a higher stress can be endured repeatedly without impairing the final ductility or the ductility which may incidentally be called upon to display itself. That leads to the higher carbon and, to be conservative, I think around about .65 to .70 is a fair limit.

The dangers of higher carbon, as I see them, are along these lines: With higher carbon steel, and high wheel pressures, we reach an unsatisfactory condition. To follow the action of the high wheel pressures, they move the metal on the sur-

face of the head and induce internal strains of compression. These internal strains of compression may be of considerable magnitude, and when they exist there must be a tensile component in the steel below it, so that we have just below the running surface of the head, metal which is put into tension, and if structurally slightly unsound, there is an opportunity for an incipient fracture to develop in that tensile part of the steel. Now, to show that the stresses from a disturbing cause like that are considerable, I would mention an instance of this kind, referring to a steel forging which had walls 3 in. thick. The metal of that cylinder was so disturbed by light hammering with a hand hammer that the bore was enlarged. The dimensions of this cylinder were 8-in. bore, 15-in. outside diameter, leaving a 3½-in. thickness for the walls. Hammering the outside surface of that cylinder stretched the bore. Turning off ⅛ in. of metal on a side restored the diameter of the bore to its original dimension. That showed that the internal strains in a zone only ⅛ in. thick were capable of stretching the balance of 3½ in. and making its effect measurable. It means a good many thousand pounds pressure per square inch to do that, so that you can see the cold rolled surface of the head of the rail may have internal strains amounting to many thousand pounds per square inch induced. These strains, coupled with the fact that we may have a decarbonized exterior and hard center, the decarbonized exterior responding easily to the rolling of the wheels, and the hard interior, through its natural ductility, not being able to respond so well, furnish the opportunity of starting a fracture in the hard steel by reason of the lack of uniformity of the metal from the outside toward the center.

These are the things which we recognize as important in considering what the composition of the steel should be and would lead to limiting it to about the figures which I have mentioned, and to the exercising of care to see that the steel in the finished rail is fairly uniform in its composition from the exterior surface to the center of the head.

Mr. Churchill: Do you not think that the lowering of the phosphorus that we get in the open hearth process is a very valuable item to balance the large amount of carbon in the Bessemer?

Mr. Howard: I think that is undoubtedly true, but the effect of these metalloids, which is well recognized, does justify us in keeping them to the minimum.

Robert Trimble (N. W. Sys., P. L. W.): Mr. Howard has talked about the large internal stresses which are set up. Take a steel with an ultimate tensile strength of about 150,000 pounds per sq. in., how much internal stress can be set up in that steel without causing a fracture?

Mr. Howard: The internal stresses set up in steel can easily reach the elastic limit of the steel, so that if that steel had an elastic limit of 75,000 to 85,000 pounds per sq. in., we could closely approach that stress.

Mr. Trimble: You could not go over that?

Mr. Howard: No. When the steel is disturbed by cold working internal strain is certain to result. The intensity of the internal force may coincide very closely with the elastic limit of the material.

Mr. Lindsay: I would like to ask Mr. Howard if in his opinion the process of annealing would permit the parts to adjust themselves against the internal strain?

Mr. Howard: Annealing certainly does restore the equilibrium. Steel responds very readily to annealing temperatures. The annealing to be efficient has to be carried on at such a temperature that the metal does not have any elasticity. At the higher temperatures of annealing, the metal is in a viscous, plastic state.

Mr. Churchill: So far as Mr. Howard's statement refers to paragraph No. 4 of the specifications, I would state that the chemistry is the best we have in service to-day. It is not the extreme, one way or the other. The carbon content is the limit prescribed in a number of both manufacturers' and other specifications that have been used recently, and it is the limit which the manufacturers say they can work in.

Mr. Churchill: I want to call attention to the fact that we mark the gage specified in section 11 on either the head or the base, which allows it to be tested either with head up or down. Undoubtedly, rails break oftener from the top down. Hence, a test with top down is safe.

Mr. Fritch: The maximum temperature of the test pieces, specified in section 12, was changed from 120 to 100, was it not? I would like to know the purpose of that change.

Mr. Churchill: It was felt by many that 120 deg. was too high a limit, that would result in not giving a correct gage on the results of the test.

Mr. Churchill: Section 14 is an important addition to the specifications heretofore issued. Diagrams presented with the specification show the elongation and ductility to vary with the other tests. One of the best tests of structural steel is the elongation or contraction in 8 in. We want to use a test for rail that can be made quickly and at the same time bring out this same comparative information. The ductility test shows a very fair correspondence with the tensile test, for example. In other words, this gives us a quick means of finding the toughness or ductility of the material, the same as we find in a longer method, impracticable in a rail.

Mr. Sullivan: Now, is it not a fact that the elongation bears a direct ratio to the middle? Can you not measure elongation by the middle ordinate for a 3-ft. cord, rather than by these gage points?

Mr. Churchill: We don't agree that there is a direct ratio between the two. We started out a few years ago with the idea that the permanent set would be something of a guide, to give an idea of the character and uniformity of material, but last year's report showed that there is very great variation in the permanent set measurements. The minimum ductility is a better gage, and it is for that reason that it is suggested.

Mr. Fritch: The committee, in commenting on section 15, says that it is the intention, when sufficient data is at hand, to prescribe maximum and minimum limits for deflections under the drop test, and that this method of classifying rails is only tentative. I do not think any of us would reject rails on this specification, and it occurs to me that that paragraph could just as well be left out until we have reached definite conclusions as to where the maximum and minimum should be fixed.

Mr. Churchill: It is an extremely easy thing to measure the permanent set at the time the elongation is measured. and the permanent set becomes the check on too soft material. We want this information and we hope it will be taken. It is not an item mandatory or a basis for condemning the rail, but we think that we will have, at least, in time, a figure for the maximum set to determine when a rail is too soft.

Mr. Churchill: The test specified in section 16 shows, whether or not the material is too brittle, or in other words, whether enough discard has been made to secure sound material. The method of testing, specified in section 17, or rather the additional number of tests, are made first to discover anything that is defective, and, second, to prevent throwing away any good material. We have proved, in the last two years, that the making of tests in this manner is very quickly done and is not a costly affair. The result of these three trials, on a Bessemer heat of steel, will reduce to a minimum the amount of material that is thrown away. It is conceivable that the full ductility of the metal is not secured under one blow, therefore we make a second blow in that case. If the rail does not break in two blows, for example, we want to go on with another test, which is the breaking to destruction to find out the character of the inner metal as far as the eye can determine, to find out whether there are any interior flaws.

Mr. Seddon: I would like to ask the committee whether they have considered at all the breaking of a piece from the top of each ingot. The drop test is all right so far as that ingot goes, but it does not seem to me that that would necessarily tell us anything about the soundness of the top rails of the other ingots.

Mr. Churchill: This method carries out the general practice in all steel testing. We do not test every ingot of any structural steel. We think it would not be possible to keep the mills running and test every individual ingot. We do not say that as a finality. It is certainly in the right line to test more ingots.

Mr. Fritch: It seems to me we ought to quit taking a chance on accepting a lot of rails about which we know nothing in regard to the soundness of the material. The only way we can arrive at that is to take a test piece from each ingot and test it to destruction. It need not be a test piece of the full length, as specified here. A shorter test piece can be taken, and if it does involve a slightly additional cost it certainly will be worth the trouble. The specifications are a great advance over previous specifications, especially in the open hearth, where they take a test piece from three ingots, but if there are sixteen ingots you must take a chance on them. You know nothing positively about them, and while the primary test is all right, as far as it goes, we should have some secondary test made for soundness, about as follows:

"In addition to the primary tests above provided, the remaining ingots not tested shall be subjected to the following tests, to insure sound rails from each individual ingot.

"A test piece shall be taken from the A rail and if when nicked and broken it shows no interior defect, all the rails of that ingot shall be accepted. If, when nicked and broken,

it shows interior defects, the A rail of that ingot shall be rejected and a test piece taken from the B rail. If the test piece, when nicked and broken, shows no interior defect, all the remaining rails of the ingot shall be accepted. If the test piece, when nicked and broken, shows interior defects, all the rails above and including the B rails of the ingot shall be rejected, and a test piece taken from the C rail and tested in the same manner, and this process shall be continued until the remainder of the rails of the ingot are tested wherever the presence of interior defects is developed."

Mr. Churchill: We would prefer that you turn that suggestion over to us and let us work on it. We don't think it can be carried out just at present. The whole intent of Sections No. 17 and No. 18 is to encourage tests. This association was responsible, a few years ago, for increasing the number of tests from one in five heats to one in each heat. I believe, as we use these specifications, we will soon be in hearty accord in multiplying tests. The same force is there constantly at the drop-testing machine, and I see no reason in the world why, if any question is raised about any ingot or any test, an inspector should not say, "We will go on and test the next ingot;" and especially is that true in open-hearth steel, where the heats are larger.

Mr. Sullivan: A number of our Canadian mills have proposed voluntarily to sell us rails on the test of the top piece of every ingot, at 50 cents per ton extra. Did I correctly understand Mr. Churchill to state that he would keep hammering a rail until he got the required ductility?

Mr. Churchill: I think it would be a mistake to say that a 100-pound rail must show a given ductility as a minimum, with an 18-ft. drop. If that rail will stand the 18-ft. drop, we have no measure of its ductility. It has shown that it is not brittle, and there is every indication from the first that the bloom has been properly discarded, but we haven't the measure of the ductility.

Mr. Sullivan: The drop test is the physical check on the chemical composition. If one rail did not bend and other rails bent at the first drop, it would indicate it was either high in phosphorus or carbon. Have any rails been accepted under that specification?

Mr. Churchill: Yes.

Mr. Kittredge: The specifications of the New York Central have required subsequent blows. It is the universal practice with our rail inspectors.

Mr. Fritch: It occurred to me that Section 29 would read a little better if it were changed to read, "Rails accepted will be paid for according to actual weights."

Mr. Churchill: We accept that.

A motion that the specifications, as amended, be adopted, and printed in the manual, was carried.

ROADWAY.

(1) FORMULAE CAPABLE OF GENERAL APPLICATION FOR DETERMINING WATERWAY AREAS.

The committee has been considering for several years the possibility of preparing, or of selecting from the various formulæ in common use, one that can be recommended for general application. The investigation made since the report to the annual convention in March, 1909, does not warrant the committee in varying from the opinion then expressed and accepted by the association:

"(1) In determining the size of a given waterway, careful consideration should be given to local conditions, including flood height and flow, size and behavior of other openings in the vicinity carrying the same stream, characteristics of the channel and of the watershed area, climatic conditions, extent and character of traffic on the given line of road and probable consequences of interruptions to same, and any other elements likely to affect the safety or economy of the culvert or opening.

"(2) (a) The practice of using a formula to assist in fixing the proper size of the waterway in a given case is warranted to the extent that the formula and the values of the terms substituted therein are known to fit local conditions.

"(b) Waterway formulæ are also used as a guide in fixing or verifying culvert areas where only general information as to the local conditions is at hand.

"(c) The use of such formulæ should not displace careful observation and the exercise of intelligent judgment on the part of the engineer.

"(d) No single waterway formula can be recommended as fitting all conditions of practice."

To the above the committee added the following conclusions in its report to the annual convention in March, 1911:

"(1) There is a general relationship between the best-known waterway and run-off formulæ. This relationship may be expressed by two terms, a varying co-efficient and a varying exponent.

"(2) The extent of this relationship for large and small areas is indicated by the Dun waterway data."

The committee's work since the twelfth annual convention has been directed toward the consideration rather of the hydraulic features of the culvert, and while some progress has been made, the committee is not prepared now to make any definite recommendation.

(2) UNIT PRESSURES ALLOWABLE ON ROADBEDS OF DIFFERENT MATERIALS.

The committee has been collecting information for two years for the purpose of formulating a conclusion as to what unit pressures are allowable on the roadbed, and has come to the conclusion that since the available data treats of the sustaining power of soils below the surface, rather than of that of soils peculiarly exposed as the roadbed is to moisture, to the action of frost, and to the loadings peculiar to train service, it will be necessary to make experiments to determine the magnitude and distribution of the loads transmitted to the roadbed through ballast of various kinds and also to determine by test the bearing power of various materials under varying conditions ordinarily attained in the construction of the roadway. The committee submits as information the following memorandum prepared by W. M. Dawley, vice-chairman, after adjournment of the November, 1911, meeting:

"The safe bearing power of soils depends upon their character or composition, depth of strata, amount of water

J. E. WILLOUGHBY.

Chairman Committee on Roadway.

they contain or are liable to receive and the degree to which they are confined.

"Practically all of the published data in relation to the bearing power of soils is in connection with foundation work for bridges and buildings and the bearing values given are for loads applied at varying depths below the surface of the ground, hence on soils more or less well confined, and serve merely as a rough guide to the bearing power of soils other than rock when the load is applied at the surface and the soil is unconfined.

"The accompanying table from 'Data' gives the safe bearing value in tons per square foot of soils and rock which may be placed on uniform strata of considerable thickness and well confined.

"Elmer L. Corthell has tabulated various existing pressures of stable structures which have shown no settlement. Data were obtained from 178 separate works, in response to a letter sent to prominent engineers throughout the world, requesting their experiences. The average value given, Mr. Corthell says, is low, and a safe one lies between the average and maximum. (See 'Allowable Pressures on Deep Foundations,' Corthell, 1906.)

"G. F. Gebhardt gives values which are an average of maximum loads allowed in most cities under the building laws.

"Richard Delafield, Brevet Major-General, Corps of Engineers, United States Army, member of Light House Board,

in 'Memoir on Foundations in Compressible Soils,' Washington, D. C., 1881, says, on page 13:

"'The compressibility of oolitic clays can only be overcome by piling, deep sinking, heavy ramming or heavy weighting. The point of bearing must be carried below the possibility of upward reaction. The depth of a foundation in compressible ground ought not to be less than one-fourth the intended height of the building above ground; that is, for a shaft of 200 ft., the foundation should be made secure to a depth of 50 ft. by piling or by well-sinking and concrete.' (Engineer and Architectural Journal, for 1837.) Masses of concrete, brick or stone, placed on a compressible substratum, however cramped and bound, may prove unsafe. *Solidity from a considerable depth alone can be relied upon.* Mere enlargement of a base may not in itself be sufficient.

"In experiments made by Hugh Leonard (M. A.) at Akra for the purpose of testing the ordinary undisturbed alluvial soil of Calcutta, 'The results showed that for Calcutta the weight on the foundation should not be more than one ton to the superficial foot.' (Journal of Royal Institute of British Architects, 1900, pp. 390-394.)

"In Cunningham's Dock Engineering, page 183, speaking of foundations for masonry dock walls, it is stated that 'The maximum intensity of pressure, at any point, should not exceed a certain limit, dependent upon the nature of

Character of Soil	Authority: I. O. Baker Min.	Max.	G. B. Francis Min.	Max.	Elmer L. Corthell Min.	Max.	Av.	G. F. Gebhardt Min.	Max.	W. W. Christie Min.	Max.
ROCK—Granite, etc., in hard, compact strata	200		Ledge Rock	36				Solid Bed Rock up to 20% of net Crushing Strength		Solid Bed Rock	200
ROCK—Limestone, equal to best ashlar masonry	25	30									
ROCK—Sandstone, equal to poor brick masonry	15	20									
ROCK—Soft and pliable as shale, equal to poor brick masonry	5	10									
ROCK—Broken and well compacted								10.0	15.0	5 to 25	
HARDPAN—Gravel and sand well cemented with clay	8	10	8		3	12	8.7				
CLAY—Thick beds and dry	6	8	3		2	8	5.08	3.0	4.0		4
CLAY—Thick beds and moderately dry	4	6						2.0			
CLAY—Soft, wet, confined	1	2	2					1.0			1
GRAVEL—Coarse and dry, well compacted and confined			5		2.4	7.75	5.1	6.0	8.0		8
SAND—Dry, compact, well cemented with clay	4	6			2.5	8.5	4.9	1.5			4
SAND—Clear and dry, confined in natural beds	2	4	4		2.25	5.8	4.5	2.0			2
QUICKSAND—Marshy and alluvial soils, silt, etc., confined	0.5	1	1		1.5	6.2	2.9	0.5			0.5

Safe Bearing Pressures Per Square Foot of Different Soils.

the ground. The safe intensity of pressure on natural foundations has been determined as follows:

On hard rock..............9 to 10 tons per sq. ft.
On soft rock and hard clay..2 to 3 tons per sq. ft.
On sand and gravel.........1½ to 2 tons per sq. ft.
On compact earth...........1 to 1½ tons per sq. ft.
On soft, uncertain ground... ½ ton per sq. ft.

"'In the case of natural foundations, care must be taken that there is no possibility of lateral escape,' and again at page 247, speaking of Lock Foundations:

"'As a general rule, hard rock and stiff clay, in which there are no springs, do not call per se for any artificial covering, except such as may be judged necessary to protect their surface from the softening and scouring action of water. On the other hand, alluvial deposits, sand, gravel and other incohesive strata, need the confinement afforded by a superimposed mass in addition to the lateral support of sheet-piles.

"'Earth of a porous nature, moreover, is not only unsuitable for a natural floor, but is equally undesirable as a foundation for an artificial floor, owing to its efficacy as a medium for the transmission of water pressure, on which account any covering laid upon it should be both strong and impervious.'"

Alfred C. Prime reports as follows:

Rock Subgrade.—"A good quality of rock will stand up under the heaviest axle loads and under Class 'A' traffic it is sustaining axle loads on one pair of drivers of 61,500 lbs. without any signs of failure. Considering this load as distributed over two ties, gives a unit pressure of 850 lbs. a sq. ft. As stated previously the limit of bearing is unknown, but a good quality of rock will probably sustain, with proper ballast, the highest axle loads that can be placed upon it.

Clay Subgrade.—"I never had any satisfaction in maintaining tracks where roadbed subgrade was composed of clay. It has always resulted in a high maintenance cost. The track will get out of line and surface and will require from one-third to one-half as much work again as where loam or sand is used. I personally believe that clay should

	Load Per Sq. Ft. Lbs.	Total Load Lbs.	Settlement in Inches: Dec. 13-17	Dec. 19	Dec. 24
Pit No. 1	650	6100	$\frac{3}{8}$	$\frac{1}{8}$	$\frac{5}{32}$
Pit No. 2	1000	9280	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{1}{2}$
Pit No. 3	1300	12000	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$

F. T. Llewellyn Tests on Soils at New Orleans.

never be used in fills on account of its high maintenance cost.

"A good grade of yellow clay will under Class 'B' traffic and axle loads of 61,500 lbs. with 6 in. of cinder ballast just sustain a pressure of about 900 lbs. per sq. ft. The speed of trains averages 60 miles per hour.

Sandy Loam.—"This has always given me satisfaction where I have used it and had to maintain track. Under Class 'A' and 'B' traffic, speed 60-70 miles per hour, with a proper depth of ballast it will maintain the heaviest axle loads that can be placed upon it. I know it is maintaining pressures of 900 lbs. per sq. ft. and how much more it is capable of sustaining is unknown.

Ocean Sand.—"For Class 'C' traffic this is a satisfactory subgrade for loads up to 700 lbs. per sq. ft., which is about the limit of economical maintenance.

"A sand subgrade can be made to sustain Class 'B' traffic by raising track about 18 in. on engine cinders.

"All figures given above are for a single track roadway 20 ft. wide with slopes of 1½ to 1, and good drainage, with 6 in. of cinder ballast below base of tie, and a tie spacing of 22 in.

"The only cheap and inexpensive method for determining unit pressures on subgrades, known to me, is to spread

Location of Tunnel	Date of Installation	Rate of Grade	Location of Fans	Length of Tunnel, Ft.	Section Sq. Ft.	Contents Cu. Ft.	Cu. Ft. Air delivered per min. through Tunnel	Remarks
N. & W. Ry. Elkhorn, Coaldale, W. Va.	6-01	+1.4%E	Lower End	3000	ST235	705000	400000	Train ton rating inc. in 1901, 100 tons.
C. & O. Ry. Big Bend, E. Hinton, W. Va.	12-02	⅓ Lgth. +0.4%E	Upper End	6500	ST250	1625000	300000	Train ton rating inc. 228 tons.
P. R. R. Gallitzin, W. Altoona, Pa.	4-05	+0.5%W	Lower End	3600	ST324	1166400	502000	
P. R. R. Washington, D. C., Station	12-07	+0.13%S	Upper End	Tubes 4050 Sta. 760	1 tube 260 2 6 tracks	3371800	640000	2 tubes, 520 sq. ft. Station end variable.
P. R. R. North and East Rivers, N. Y.	9-10	Special vent. of	installat tubes th	ion 14 fa at are 41	ns for e 35 ft. to 225	mergen 7357 ft.	cy uses 40000 to 111000	
B. & O. R. R. Kingwood Tunnelton, W. Va.	12-10	+1.0%E	Lower End	4138	ST352	1458000	600000	Train ton rating inc. 450 tons.
C. & O. Ry. Lewis, Alleghany, Va.	6-11	+1.14%W	Lower End	4026	ST318	1280200	508800	
N. Y. C. Lines Weehawken, N. J.	8-11	+0.25%E	Lower End	4365	DT469	2047200	512000	144 trains per day.
P. R. R. B. & P. Tunnel, Baltimore, Md.	9-11	+1.32%S	Upper End	4963	DT432	2150000	500000	193 trains per day.

Record of Tunnel Ventilation.

some pliable substance such as fairly thin sheet lead on top of your subgrade for a length of say 5 ft. As long as this remains straight and undeformed your allowable unit pressure on subgrade is not being exceeded, but the moment it becomes cupped and dished under the ties, the unit pressure for this class of roadbed subgrade is too high.

"In connection with this work the report of the M. W. & S. Committee on Roadbed of the Altoona Railroad Club in May, 1909, on 'Drainage of a Four-Track Railroad,' con-

tains some interesting matter, also a paper by M. L. Byers in the Bulletin of the International Railway Congress for September, 1909."

In December, 1898, F. T. Llewellyn made some tests to determine the safe load on soils at New Orleans. Pits 4 ft. x 4 ft. x 5 ft. deep were used, the water surface being 18 in. below the bottom of pit in blue clay. A wood foundation 3 ft. x 3 ft. of 3 in. x 12 in. plank doubled and crossed was used.

O. E. Selby, bridge engineer, C. C. C. & St. L., using the formula derived by Thos. H. Johnson, calculates the average pressure on subgrade to be 2.4 tons per sq. ft., and the maximum to be 3.6 tons for 50,000-lb. axle loads spaced 5 ft. centers, 80-lb. rail, 7 in. x 8 in. x 8½ ft. ties spaced 20-in. centers on 12 in. of gravel ballast.

From what has preceded it will be observed that the safe bearing power of confined soft wet clay, clear dry sand confined in natural beds, quicksand, marshy and alluvial soils, silt, etc., all confined, is less than or very slightly in excess of the pressures calculated by Mr. Selby. If unconfined their bearing powers will all be somewhat reduced.

Semi-fluid soils such as quicksand, alluvium, etc., should be removed where practicable or the foundation carried to a lower stratum, so the bearing power of such need not be considered here.

The bearing power of clay, loam, sand, etc., depends to a great extent on the amount of moisture present.

Professor Schubler of Tübingen found that 100 lbs. of dry soil would retain the following amount of water that would not flow off:

Pure Clay	70 lbs.
Clay Loam	50 lbs.
Loamy Soil	40 lbs.
Sand	25 lbs.

(Drainage Farm Journal, August, 1884.)

The water which destroys the bearing power of such soils may come from below by capillary attraction, the vertical capillary movement per horizontal square foot per 24 hours being as follows:

In fine sand through 1 ft. vertical	2.37 lbs.
In fine sand through 2 ft. vertical	2.07 lbs.
In fine sand through 3 ft. vertical	1.23 lbs.
In fine sand through 4 ft. vertical	.91 lbs.
In medium clay loam through 1 ft. vertical	2.05 lbs.
In medium clay loam through 2 ft. vertical	1.62 lbs.
In medium clay loam through 3 ft. vertical	1.00 lbs.
In medium clay loam through 4 ft. vertical	.90 lbs.

(See page 65, "Movements of Ground Water," by Franklin H. King and Charles S. Slichter, Government Printing Office, Washington, D. C., 1899.)

If, as Professor Baker says, dry clay will sustain a load of from six to eight tons per sq. ft. and soft wet clay will support but from one to two tons per sq. ft., it seems that the bearing power of clays and soils similarly affected by the presence of moisture should in each case be experimentally determined for varying percentages of moisture and such drainage arrangements made, and at such depths, as will always secure a percentage of moisture low enough to bring the bearing power up to the load it is required to carry.

(3) TUNNEL CONSTRUCTION AND VENTILATION.

The committee recommended to the annual convention of 1910 the cross-section to which tunnels should be constructed to conform to good practice. The recommendation was adopted, and the committee has since that convention confined its attention principally to the question of ventilation. No definite conclusion has been reached, but the opinion of the committee leans to a belief that artificial ventilation is usually unnecessary in American steam railway tunnels of less length than 2,000 to 2,500 ft., and that probably the most efficient form of artificial ventilation is to force air into one end of the tunnel by fans powerful enough to drive the smoke out ahead of the train. This method was adopted for the Elkhorn tunnel on the Norfolk & Western and is admirably described by Chas. S. Churchill in the Transactions of the American Society of Civil Engineers, Vol. 54, part C. Plants similar to that constructed for the Elkhorn tunnel have been installed as shown by the accompanying table. The committee has advice that the Baltimore & Ohio is now experimenting on single and double track tunnel ventilation, but the various methods used in the different tunnels are at such great variance that no conclusion has as yet been reached.

(4) AGRICULTURAL DRAINAGE AS IT AFFECTS RAILWAYS.

During the past two years the committee collected information as to the drainage laws of the various states, but has never been able to fix upon a form into which the information can be put so as to make it of value to the assocation. The committee is of the opinion that further work along the line of collecting information as to laws and assessments is futile because the laws are changing constantly, and because the committee's information is necessarily general and not subject to application to specific cases without legal advice; and further, questions affecting the laws and assessments are, in all railway organizations, handled by the railway's attorneys. The committee recommends that it be discharged from further consideration of the subject as to laws and assessments.

CONCLUSIONS.

The committee recommends that subjects 1, 2 and 3 be reassigned and that further consideration of subject 4 be confined to the benefits to the roadway to be derived by the construction of agricultural drainage ditches and levees. The committee believes that certain additions can be made to the specifications as now printed in the manual, for example, the sodding of slopes of cuts and fills.

The committee directs attention to a resolution passed at its meeting on November 28:

"Resolved, That the board of direction be requested to set aside an appropriation and to appoint a special committee, consisting of members of the roadway, ballast and track committees, to make experiments to determine the magnitude and distribution of the load transmitted to the roadbed through ballast of various kinds and also to determine by test the bearing power of various materials under varying conditions ordinarily found in the construction of the roadway."

The report is signed by J. E. Willoughby (L. & N.), chairman; W. M. Dawley (Erie), vice-chairman; J. R. W. Ambrose (G. T.), John C. Beye (C. R. I. & P.), D. J. Brumley (I. C.), W. C. Curd (M. P.), Paul Didier (B. & O.), R. C. Falconer (Erie), S. B. Fisher (M. K. & T.), T. H. Gatlin (Southern), C. S. Millard (C. C. C. & St. L.), W. D. Pence (Univ. of Wisconsin), A. C. Prime (P. R. R.), Hiram J. Slifer (C. G. W.), J. A. Spielmann (B. & O.), John G. Sullivan (C. P.), F. L. Wheaton (D. L. & W.), W. P. Wiltsee (N. & W.), R. C. Young (L. S. & I.).

In the absence of the chairman, W. M. Dawley (Erie) presented the report, which was received as a progress report.

WATER SERVICE.

The following subjects were assigned:

(1) Report on the design and relative economy of track pans from an operating standpoint.

(2) Present typical plans and specifications for tank supports.

(3) Report on the use of reinforced concrete for water tanks and supports.

It was decided, since the subject of "Water Tanks," including supports, had been under consideration so long, to request the board to drop subject No. 2 and substitute "Deep Well Pumps," approval of which was given later.

A Sub-Committee on Water Treatment was appointed with the idea that the committee should have such a sub-committee every year whose duty it would be to keep informed of the progress in this subject, and make reports as seemed desirable.

(1) The committee reports progress on the design and relative economy of track pans from an operating standpoint. No further report is made for the reason that such additional data as can be secured is from elaborate tests made by the Pennsylvania Railroad at Atglen, Pa., which are not yet available. The committee also hopes to secure a report prepared for a special committee of the New York Central Lines by G. W. Vaughan, engineer maintenance of way of that railway.

(2) It also reports progress on the study of deep well pumps. This subject has not been developed sufficiently to report otherwise.

(4) The committee reports progress in the study of water treatment.

(3) THE USE OF REINFORCED CONCRETE FOR RAILWAY WATER TANKS AND SUPPORTS.

Reinforced concrete tanks have been built either as standpipes or as elevater tanks on concrete towers.

The advantages are:

(1) Low maintenance cost.

(2) Great durability.

This may be true only of well-designed, well-built and water-tight tanks.

The disadvantages are:
(1) Innovation in railway service.
(2) Imperfections in materials and workmanship.
(3) Greater first cost.
(4) Porosity of the concrete.
(5) Shrinkage of the concrete.
(6) Stretch of the concrete.
(7) Difficulty of waterproofing.
(8) Effect of frost on saturated concrete.
(9) Ugliness.
(10) Immovablity.

No. 1 will be removed in time if the concrete tank develops sufficient merit.

No. 2 is more incidental than fundamental, but the making of a strictly uniform high-grade monolithic concrete construction without local imperfections is difficult and requires highly efficient workmanship.

No. 3 may be justified by the advantages named. It can be shown in some cases that a reinforced concrete tank costs less than a steel tank of like capacity, but in such cases the design is probably sparing in the use of steel and concrete. A thin shell and a high stress in the steel are liable to result in a leaky tank. Generally, when the stress in the steel is low enough and the tank shell thick enough

ROBERT FERRIDAY.
Chairman Committee on Water Service.

to insure against leakage, the cost of a reinforced concrete tank will be greater than that of a steel tank.

No. 4 is the root of much of the trouble with the concrete tank. It is not an insurmountable difficulty. Careful selection and grading of sand and stone, liberal use of cement, complete and uniform mixing and proper placing will make a concrete impervious under the pressures required for railway water service. Serious leaks will be due to local imperfections rather than to porosity if the tank has been well-designed and constructed of a proper grade of concrete.

No. 5 is a more fundamental difficulty. Shrinkage of concrete in setting is inevitable and it is increased by the large proportion of cement required in water tank construction. This frequently produces cracks, especially along the joints between successive courses of concrete. Careful and proper making of the joints and judicious steel reinforcement are necessary to prevent serious shrinkage cracks. The steel dam mentioned in the accompanying general specifications is a desirable thing in the joints when the concrete in the first half of the joint has hardened before the concrete in the second half is placed.

No. 6 is a serious difficulty in the shell of the tank due to elasticity of the steel reinforcement and its stretch under the water load. Any concrete, however dense and impervious in its unstrained condition, can be stretched beyond its breaking strength and fine cracks through which water will flow under pressure may be opened therein by stressing the steel within the elastic limit of the latter. If the tank could be maintained constantly full of water the moderate leakage due to such stretch would generally stop through deposits of suspended matter from the filtering water. In some cases this would be assisted by chemical precipitation. But, under general service conditions there is a wide fluctuation of pressure and the elastic recovery of the steel as the pressure drops appears to break down the plugging action of the leakage above indicated in those cases where the steel is stretched materially beyond the breaking point of the concrete.

Herein appears to lie a formidable handicap of the concrete tank as a competitor of the steel tank on the basis of cost. The effectual remedy appears to be the combination of that low stress in the steel with that increased thickness of the shell which will limit the stretch of the concrete so that cracks permitting the filtration of water will not be opened. That increases the cost of concrete and steel, making the latter approach the cost of steel in a steel tank.

The committee is of the opinion that the ultimate stress of the steel without assistance from the tensile strength of the concrete should not exceed 10,000 lbs. per sq. in., and that the minimum thickness in inches of the concrete at any point should be such that when the total tensile stress due to water load at that point is diminished by 3,000 times the sectional area in sq. in. of the steel at that point, the remaining water load will stress the concrete at that point 300 lbs. per sq. in., provided that in no case shall the thickness of concrete be less than 4 in. The committee does not say that concrete will not break under a tensile stress of 300 lbs. per sq. in., although experiments indicate that concrete of the high grade required for tank construction may have an ultimate tensile strength of 400 to 500 lbs. per sq. in.

This specification as to thickness of concrete is an arbitrary one intended to secure a minimum and reasonable thickness somewhat in excess of the thickness of concrete in tanks already constructed in which the stress in the steel has been 12,000 lbs. or more per sq. in., resulting in some leakage. The primary object is to secure a minimum thickness of wall in which tension cracks, if any, will be localized and minute and through which it would be difficult for water to pass. The size and the arrangement of the reinforcing rods have an important bearing on the minimum permissible thickness of concrete. The shrinkage of the concrete around large rods in a thin wall is liable to crack the concrete.

The trouble from stretch of the concrete raises the question as to the practicability of designing a tank shell to be in compression. This could be accomplished by building the shell as a series of short, flat, abutting arches convex to the center of the tank with the reinforcing steel supported by exterior pilasters forming the abutments of the arches, as indicated in the suggested plan and elevation of a section of concrete tank shell designed to be in compression appearing on the accompanying drawing, showing a general plan and general section for a suggested concrete standpipe. The radius of the arches may readily be proportioned to make the total compression in the concrete equal to the total tension in the steel. The reinforcing rods between the pilasters may be covered by metal lath and cement plaster. The density and imperviousness of the concrete in the arches would be increased by the water load. The polygonal form of the tank with its recessed panels would break the monotony of a plain cylinder and give the tank an improved appearance. Doubtless difficulties would arise in the execution of such a design, but without going into details, the suggestion is offered for what it is worth.

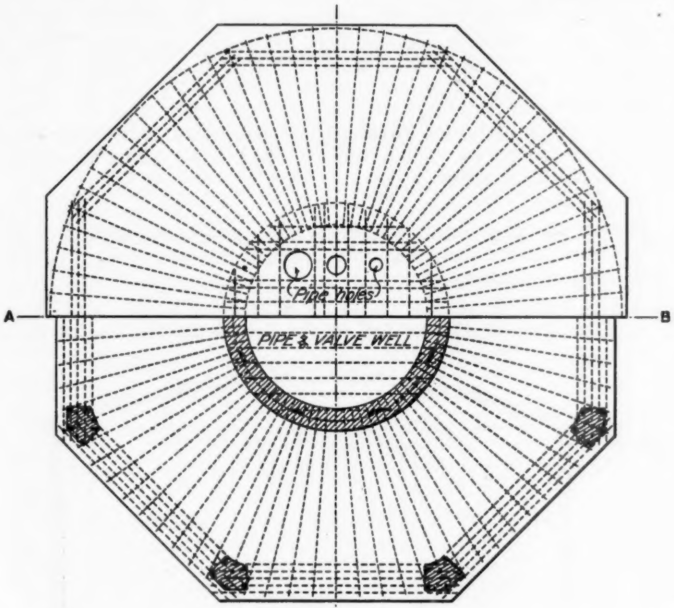
No. 7 arises from 4, 5 and 6. The problem is to find some foreign substance which, when incorporated with the concrete, will close the percentage of voids found even in the best grade of concrete, or, when applied to the surface, will be impervious and will not crack or peel off. In either case the trouble is aggravated and the waterproofing largely nullified by the shrinking and stretching of the concrete unless the latter is properly reinforced against shrinkage and stretch. Tanks in service prove that it is practicable to make concrete impervious under ordinary tank pressures by proper selection, grading and mixing of materials. Soap and alum incorporated with the concrete in the making and applied as washes to the surface are probably the best proved and most efficient materials for effective waterproofing of concrete.

No. 8 is a danger which will be eliminated by successful solution of waterproofing. Since the latter will require as its base a very dense concrete, the quantity of water passing through the latter will be so small that the action of frost can have little or no effect on such close grained and practically dry concrete. It is a fact, however, that in our northern latitudes much disintegration of porous concrete on the water line of lakes and streams due to the annual effect of the frost season is apparent.

Ugliness is a sin chargeable to some railway structures

other than water tanks. Perhaps a little additional homeliness is not unpardonable if saved by the grace of utility. Monolithic concrete, especially a form-marked, joint-marked, leaky efflorescent tank shell possesses a lack of beauty which is not hidden by frills. The attainment of a water-tight tank requires a high grade of material and work which will go far toward making concrete tanks presentable in appearance.

An irremovable objection to the concrete tank is its immovability. A wooden tank and even a steel tank can be and such tanks are moved from place to place to meet changing requirements of railway water supply. Discovery of new and better water supplies sometimes makes changes in locations of tanks desirable. A concrete tank should be



Half Deck and Half Foundation Plan of Substructure for Reinforced Concrete Water Tank.

located only at those points where there is no probability of change.

Considering the obvious merits of the concrete tank, the committee sees no reason why railways engaged in permanent reconstructions for fixed water supplies should not favorably consider a beginning in reinforced concrete tank construction. Water-tightness is the important problem. The stability of this form of construction is well established.

Many existing concrete tanks are practically water-tight. Generally, leakage is immaterial in amount and objectionable principally as a matter of appearance and a possible danger account of frost. It is more often the result of local imperfections, bad joints, and a thin shell and a high stress in the steel than porosity and permeability in a proper grade of concrete.

The committee submits as information:

(1) General Specifications for Reinforced Concrete Standpipe Water Tanks for Railways. No plans of tank are submitted with these specifications.

(2) Suggestive sketches consisting of: An elevation and section of reinforced concrete standpipe tank. A section through valve box in the foundation. A plan and elevation for reinforced concrete tank shell designed to be in compression. An elevation and section of reinforced concrete tank on a reinforced concrete substructure, and a plan, elevation and section of reinforced concrete substructure.

The tank should be located away from the main line track and should deliver water to engines through water columns.

If a roof is required, it should be built as shown. Where ice will not form to an injurious or troublesome extent and sunlight will not cause vegetable growth in the water, the roof may be omitted.

For a given amount of available storage and considering piping, frostproofing, and collection and disposal of sludge, the standpipe is simpler and more economical than a tank on a tower, notwithstanding it is practicable to erect a concrete tower 20 ft. high including foundation at an expense less than the cost of the foundation and lower 20 ft. of a concrete standpipe. This refers to railway service. For quantities of water required only at higher elevations, the concrete tower may readily be more economical than the standpipe.

The construction of the concrete tank on the concrete substructure would not differ materially from that of the concrete standpipe, and the general specifications for the latter may be applied generally to the former.

The substructure may also be used for supporting tanks of wood or steel. Its general design consists of an octagonal foundation slab and an octagonal desk slab, the latter being carried on the reinforced columns and the central pipe and valve well resting on the foundation. The plan shows the general arrangement of the reinforcement. The foundation slab distributes the load under its entire area, keeps the unit load low and is favorable to uniform settlement, if any. On a rock foundation this slab may be omitted. The central well serves for enclosing and frostproofing the piping and valves, helps to support the deck and makes the entire sub and superstructure stable against wind pressure without assistance from the surrounding columns. The plan contemplates a substructure not more than 20 ft. high above the ground, in which case the columns require no lateral bracing. In the construction of the substructure the ordinary approved building loads, stresses, materials and workmanship for reinforced concrete are acceptable and sufficient. The question of waterproofing does not enter unless it is desired to make the deck slab the bottom of the tank when the latter is made of concrete.

These general plans are submitted, not as those which should be adopted, but as suggestions for a number of good designs which could be made.

GENERAL SPECIFICATIONS FOR A REINFORCED CONCRETE STANDPIPE WATER TANK FOR RAILWAYS.

Definitions.

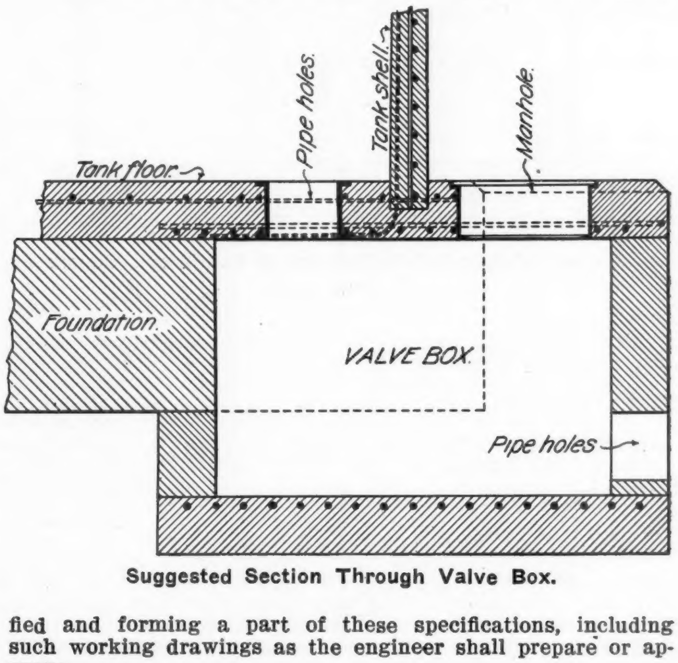
1. The words "company," "engineer," "as shown," "drawings," and "this association," appearing in these specifications, are defined as follows:

"Company" means the railway company building a tank under these specifications.

"Engineer" means the engineer of the company.

"As shown" means as shown on the drawings.

"Drawings" means the drawings of the tank herein speci-



Suggested Section Through Valve Box.

fied and forming a part of these specifications, including such working drawings as the engineer shall prepare or approve.

"This association" means the American Railway Engineering Association.

Kind.

2. This tank shall be of reinforced concrete as shown.

Excavations.

3. In earth, excavation for the foundation should be as deep as the lowest frost line. In rock, only the excavation for the valve box should be carried below the action of frost. In earth, the bottom of the excavations should be thoroughly tamped. If the earth will not sustain the total load, including wind pressure, without material or unequal settlement, the foundation should be supported on piles of the number, size and arrangement as determined by the engineer. Such

piles should conform to the specifications of this association for piling as selected by the engineer.

Foundation.

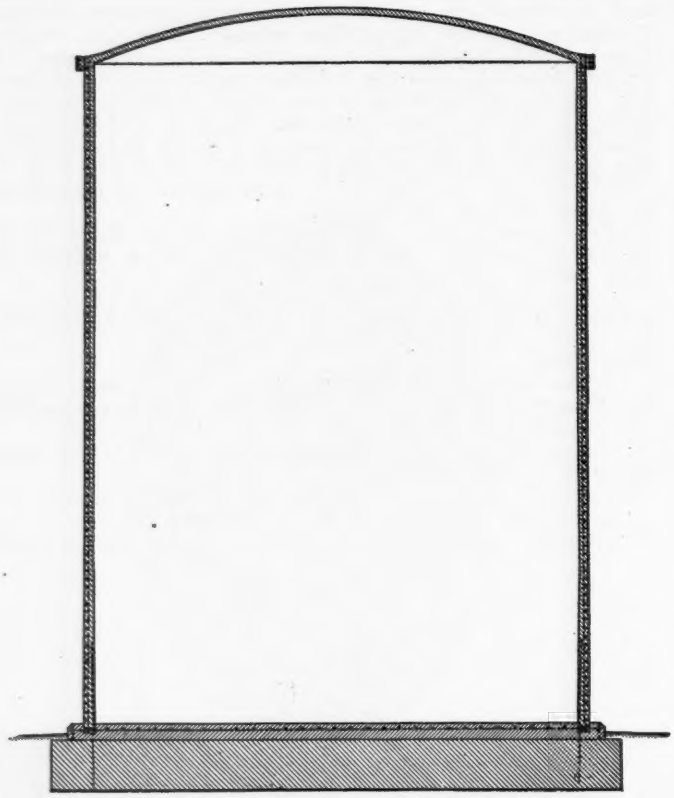
4. The foundation should be monolithic concrete of the form and dimensions as shown. If the depth of frost is excessive the foundation may be carried on broken rock uniformly compacted in the bottom of the excavation. The top of the foundation should be above the surface of the ground.

Floor.

5. The tank floor shall be constructed on the foundation as shown.

Valve Box.

6. The valve box shall be constructed as shown. When low temperatures require to prevent freezing within the



Suggested General Design for a Reinforced Concrete Standpipe.

valve box, an air space should be constructed in the middle of the valve box walls as shown.

Shell.

7. The concrete shell shall be constructed and the construction between it and the floor shall be as shown. Its thickness should have a proper relation to the sizes and positions of the reinforcing rods so that the concrete will not crack in shrinking around the rods.

Piping and Valves.

8. This tank should be equipped with standard iron pipes and stndard gate valves located in the valve box as shown. The pipes should pass from the valve box in iron sleeves with lead joints into the tank as shown. There should be a tank supply pipe, a washout pipe, a water column supply pipe, and if required, an overflow pipe. For a gravity water supply, an altitude controlling valve in the valve box or a float valve in the tank should be placed in or on the tank supply pipe as shown. The tank supply pipe and the water column supply pipe should extend above the floor of the tank, but the water column supply pipe should not rise higher than the top of the water column served. The washout pipe should terminate flush with the floor.

Gage.

9. The tank should be equipped with a gage, indicator and float as shown.

Ladder.

10. The tank should be provided with a ladder as shown.

Concrete.

11. The concrete in the floor, shell and roof shall be a thoroughly uniform and dense mixture of cement, sand, stone and water, made and laid in accordance with the specifications of this association for reinforced concrete. The volume of the sand shall be in excess of the voids in the stone. The volume of the cement shall be in excess of the voids in the evenly mixed sand and stone. The excess of sand and cement shall be such as will give the greatest attainable density in the concrete. The volume of water shall be sufficient to give the concrete a fluidity that will cause it to flow and mold itself into the forms readily and completely. An unnecessary quantity of water shall not be used. The engineer shall determine the above specified voids and proportions.

In the foundation, the concrete shall be mixed in the proportions specified by the engineer and it shall fulfill the requirements of the specifications for concrete of this association.

Mixing.

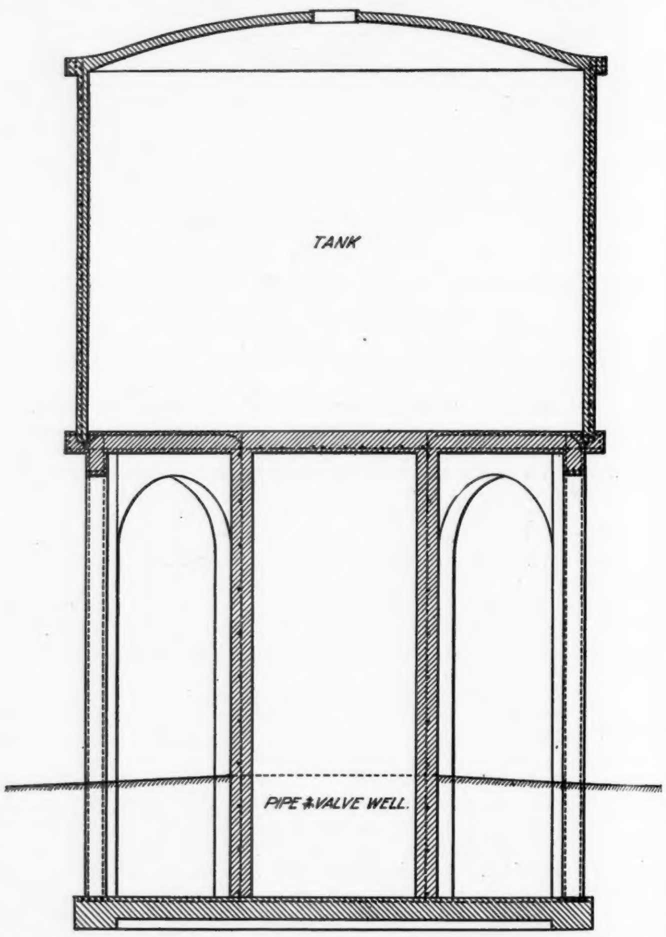
12. The concrete should preferably be mixed by batch mixing machines. The method used shall yield a complete and even mixture.

Cleanliness.

13. All dirt and foreign matter shall be excluded from all materials, concrete and stages of the work.

Pouring and Mixing.

14. This concrete, after mixing, shall be poured and worked into final position in the forms before its initial set



Suggested General Plan for Reinforced Concrete Water Tank and Substructure.

is complete, and it shall not thereafter be disturbed. As it is thus placed, it shall be thoroughly worked throughout by flat thin-bladed tools in a manner that will eliminate all voids and air pockets and produce unbroken mortar faces against all forms and secure perfect contact with every part of all reinforcing rods therein.

Joints.

15. The surface of concrete in joints should be free of laitance and all foreign matter and should be rough, fresh, clean and wet when concrete is laid thereon. The surface

should be covered with a heavy coat of grout or mortar immediately in advance of placing concrete thereon. The surface should be thoroughly tooled, scrubbed and washed preparatory to the application of grout and concrete. The new concrete should be worked into complete contact with the old concrete.

Muriatic acid or equivalent may be used as a help to the tooling and scrubbing, but all of the concrete penetrated by the acid should be entirely removed.

A metal dam of non-corrosive metal like copper should be inserted in the concrete joints intended to prevent the passage of water. The metal should be driven edgewise into the first half of the joint to a depth equal to half the width of the metal before the initial set of the concrete is complete. The contact between the concrete and the metal should be complete and perfect. The edges of the metal should be turned over 90 degrees for anchorage. Joints in the metal dam should be lapped at the ends in a manner that will secure water-tight joints.

This specification for joints does not necessarily and preferably may not apply to the joint between the floor and the foundation.

The entire process of making joints shall be as required.

Wetting.

16. Rapid drying out of concrete shall be prevented by regular, frequent and continued wetting of all exposed concrete surfaces until all danger of arresting setting and hardening is past.

Freezing.

17. Freezing of concrete before it has finally set shall be prevented.

Broken.

18. Any concrete broken or displaced in any manner after having set shall be removed from the work.

Cement.

19. The cement shall conform to the specifications of this association for Portland cement. It shall retain its original purity and qualities until it is incorporated into this work. Deteriorated or otherwise damaged cement shall not be used.

Sand.

20. The sand shall be clean, sound and sharp and it shall be of graded sized grains giving a minimum of voids.

Stone.

21. The stone shall be clean, sound and durable. The word "stone" includes broken rock and gravel. The stone shall be of graded sizes, giving a minimum of voids. All of it shall be able to pass through a circular hole having a diameter of ¾-in.

Water.

22. The water shall be clean and free from anything injurious to the concrete.

Forms.

23. The concrete forms should be made of dressed and matched lumber or of metal. They should be accurately made and erected, be water-tight and should have ample strength and rigidity to prevent bending and warping under the load and action of the concrete. They should be erected in such manner as will permit the concrete to be poured and worked as above specified.

Pointing.

24. Any break in the concrete surfaces, not impairing the integrity of the structure, shall be pointed by cement mortar as the engineer shall direct. Any other imperfections in the concrete shall be treated and remedied as the engineer shall direct.

Reinforcement.

25. The concrete shall be reinforced by metal rods of the kind, form, size, number and arrangement as shown. They shall be maintained in required position as they are buried in the concrete, at which time they shall be free from dirt, paint, oil, grease and scale. Splices in a line of rods shall be lapped far enough to develop the full strength of each rod. Throughout the splice the ends of the rods making it shall be far enough apart to develop maximum total adhesion of the concrete. Unnecessary splicing shall be avoided. No splice shall be opposite a splice in an adjacent line of rods.

Reinforcing Rods.

26. The rods shall be metal rods, plain or deformed. Their tensile strength shall be not less than 50,000 lbs. per sq. in. Their elastic limit shall be not less than 30,000 lbs. per sq. in. Their ductility shall be such that any rod can be bent 180 deg. on a radius equal to 2 diameters or sides of the rod without sign of fracture.

Stresses.

27. Assuming the metal rods to carry the water pressure and other stresses without aid from the tensile strength of the concrete, the stress per sq. in. in the rods should not exceed 10,000 lbs. Vertical reinforcement in the shell, between the shell and the foundation and across joints in the concrete should be ample to prevent opening of cracks in the concrete. Reinforcement in all necessary directions should be ample to prevent as far as practicable the opening of cracks in the concretet due to itts shrinkage in setting and to its stretching under the water load. The minimum thickness in inches of concrete at any point should be such that when the water load in pounds at that point is diminished by 3,000 times the sectional area in sq. in. of the metal reinforcement at that point, the remaining water load will stress the concrete not more than 300 lbs. per sq. in. at that point, provided that in no case shall the thickness be less than 4 in.

Loading.

28. The weight of water should be assumed to be 63 lbs. per cu. ft. Wind pressure, acting in any direction, should be assumed to be, in pounds, 30 times the product of the height by two-thirds of the diameter of the tank in feet.

Waterproofing.

29. A uniformly dense mixture of concrete as herein specified should be the primary expedient to secure water-tight concrete. This may be supplemented by mixing with the concrete some form of waterproofing compound of proved efficiency or by washing the concrete surface therewith, or by both.

The engineer shall select the waterproofing material and determine the proper proportions and methods of application.

Waterproofing by the application of rich cement mortar may be acceptable if the foregoing specification for making joints in concrete work is complied with.

GENERAL SPECIFICATIONS FOR ORDINARY STEEL WATER AND OIL TANKS.

(Revised November, 1911. Submitted with recommendation that they be printed in the manual.)

Ordinary Tanks Defined.

1. Ordinary tanks are those requiring plates not more than ⅝-in. thick.

Scope of Specifications.

2. These specifications cover ordinary steel tanks commonly used by railways for usual service conditions only.

Quality of Metal.

3. The metal in these tanks shall be a special refined steel or open-hearth steel.

The special refined steel shall have a tensile strength per sq. in. not less than 50,000 lbs. and an elastic limit not less than 30,000 lbs. per sq. in. It shall contain of

Sulphur	Not more than .02 per cent.
Phosphorus	Not more than .005 per cent.
Carbon	Not more than .02 per cent.
Manganese	Not more than .00 per cent.
Silicon	Not more than .00 per cent.

The open-hearth steel shall conform in physical and chemical properties to the specifications of this association for steel bridges.

For plates not more than ½-in. thick, ⅝-in. rivets shall be used. For thicker plates the diameter shall be ¾-in.

Loading.

4. The weight of water shall be assumed to be 63 lbs., crude oil 56 lbs., and creosote oil 66 lbs. per cu. ft. Wind pressure, acting in any direction, shall be assumed to be, in pounds, 30 times the product of the height by two-thirds of the diameter of the tank in feet.

Unit Stresses.

5. Unit stresses shall not exceed the following:

(a) Tension in plates, 15,000 lbs. per sq. in. on net section.

(b) Shear in plates, 12,000 lbs. per sq. in. on net section.

(c) Shear on rivets, 12,000 lbs. per sq. in. on net section.

(d) Bearing pressure on field rivets, 20,000 lbs. per sq. in.

Cylindrical Rings.

6. Plates forming the shell of the tank shall be cylindrical and of different diameters, in and out, from course to course.

Workmanship.

7. All workmanship shall be first class. All plates shall be beveled on all edges for caulking after being punched. The punching shall be from the surface to be in contact. The plates shall be formed cold to exact form after punching and beveling. All rivet holes shall be accurately spaced. Drift pins shall be used only for bringing the parts together. They shall not be driven with enough force to deform the metal about the holes. Power riveting and caulking should be used. A heavy yoke or pneumatic bucker shall be used for power driven rivets. Riveting shall draw the joints to full and tight bearing.

Caulking.

8. The tank shall be made water or oil tight by caulking only. No foreign substance shall be used in the joints. For water tanks, the caulking shall preferably be done on the inside of tank and joint only; but for oil tanks the caulking should be done on both sides. No form of caulking tool or work that injures the abutting plate shall be used.

Minimum Thickness of Plates.

9. The minimum thickness of plates in the cylindrical part of the tank shall not be less than ¼-in. and in flat bottoms not less than $\frac{5}{16}$-in. In curved bottoms the thickness of plate shall be not less than that of the lower plate in the cylindrical part.

Horizontal and Radial Joints.

10. Lap joints shall generally be used for horizontal seams and splices and for radial seams in curved bottoms.

Vertical Joints.

11. For vertical seams and splices, lap joints shall be used with plates not more than ⅝-in. thick. With thicker plates, double butt joints with inside and outside straps shall generally be used. The edge of the plate in contact at the intersection of horizontal and vertical lap joints shall be drawn out to a uniform taper and thin edge.

Rivet Holes, Punching and Pitch.

12. The diameter of rivet holes shall be $\frac{1}{16}$-in. larger than the diameter of the rivets used. The punching shall conform to the specifications of this association for such work on steel bridges. A close pitch, with due regard for thickness of plate and balanced stress between tension on plates and shear on rivets, is desirable for caulking.

Tank Support.

13. If the tank is supported on steel columns with bracing, the metal in such substructure shall conform to these specifications, and the anchorage and workmanship thereof shall conform to the specifications of this association for the manufacture and erection of steel bridges.

Painting.

14. In the shop the metal shall be cleaned of dirt, rust and scale and, except the surfaces to be in contact in the joints of the tank, shall be given a shop coat of paint or metal preservative selected and applied as specified by the company.

After being completely erected, caulked and cleaned of dirt, rust and scale, all exposed metal work shall be painted or treated with such coat or coats of paint or metal preservative as shall be selected by the railway company.

Plans and Specifications.

15. Under these specifications and in conformity thereto the railway company shall cause to be prepared or shall approve detailed plans and specifications for such tanks, herein specified, as it shall construct. Such plans and specifications shall cover all necessary tank auxiliaries.

CONCLUSION.

That the specifications for steel, water and oil tanks is good practice, and should be included in the manual.

The report is signed by Robert Ferriday (C. C. C. & St. L.), Chairman; J. L. Campbell (E. P. & S. W.), Vice-Chairman: James Burke (Erie), H. M. Church (B. & O.), C. C. Cook (B. & O.), G. M. Davidson (C. & N. W.), A. F. Dorley (M. P.), G. H. Herrold (C. G. W.), E. G. Lane (B. & O.), G. C. Millett (A. T. & S. F.), A. Mordecai (Consulting Eng.), W. A. Parker (St. J. & G. I.), C. L. Ransom (C. & N. W.), Chas. E. Thomas (I. C.).

Mr. Ferriday: I would recommend that we take up the specifications for steel tanks, and I can outline the changes that we desire to make:

First.—Change the title to read: "General Specifications for Steel Water and Oil Tanks."

Second.—Combine paragraphs 1 and 2 to read: "Scope of Specifications. 1. These specifications are intended for steel tanks requiring plates not more than ⅝ in. thick.

Third.—Change the numbering of the paragraphs in consequence of consolidating paragraphs 1 and 2.

Fourth.—Change paragraph 3 as to quality of metal to read:

"2. The metal in these tanks shall be open hearth steel. This steel shall conform in physical and chemical properties to the specification of this association for steel bridges.

Fifth.—Change paragraph 12 to read: "Rivets, rivet holes, punching and pitch. 11. For plates not more than ⅝ in. thick, ⅝-in. rivets shall be used. For thicker plates, ¾-in. rivets shall be used. The diameter of rivet holes shall be $\frac{1}{16}$ in. larger than the diameter of the rivets used. The punching shall conform to the specifications of this association for such work on steel bridges. A close pitch, with due regard for thickness of plate and balanced stress between tension on plates and shear on rivets, is desirable for caulking."

Sixth.—Change paragraph 13 to read: Tank Support. 12. If the tank is supported on a steel substructure, the latter shall conform to the specifications of this association for the manufacture and erection of steel bridges."

Mr. Steffens: I would like to ask the committee why they change from the unit stresses, adopted by the Committee on Iron and Steel Bridges.

Mr. Ferriday: The material is in service, under different conditions from that in steel bridges, and it was felt that the limits named here were as large as was advisable.

Mr. Steffens: I would like to ask the committee if they would be willing to put that in the shape of a factor or constant, referred to the specifications for steel bridges.

Mr. Ferriday: I don't think that would be satisfactory. I don't believe it would be desirable to have to make a computation from the specifications for steel bridges. I think it has been the practice of all the committees, for the sake of brevity, to refer to other specifications, without repeating them in detail.

Mr. Bremner: It seems to me it is proper to refer to the other specifications printed in the manual, but the committee should at some time give us one specification, giving the numbers of the paragraphs in the bridge specifications that refer to the water and oil tank specifications, so that they can be readily accessible to the members without going through the entire bridge specifications.

Mr. Berry: I suggest the preparation of plans and specifications as to tools. When we started to equip steel tanks, it had to be done by our division forces, and we look everywhere for the best and most economical plan by which to erect these tanks. We finally got up a set of drawings of tools, and had them criticized, and I believe it would be a good thing for this committee to collect such information and recommend the best class of tools for the erection of such tanks.

A motion that the specifications, as amended, be adopted and included in the manual, was carried.

MASONRY.

WATERPROOFING MASONRY.

A circular letter requesting information relative to the waterproofing of masonry was sent to the members of the association. The circular followed, in the main points, the circulars issued in former years, adding such additional questions as appeared to the committee called for in the light of present day practice. The replies were quite numerous, but only a limited number contained information on the subject under consideration. Abstracts from the replies containing information pertinent to the subject are appended. A perusal of these brings out the fact that while considerable waterproofing is being done throughout the country, the methods followed and materials used are much the same as described in previous reports of the committee.

From several replies it will be seen that impervious concrete can be made without special waterproofing, by using a suitable gradation of aggregates and the proper amount of cement and reinforcing the concrete to counteract temperature and shrinkage stresses, and also using the proper care and amount of work in depositing to secure a dense concrete.

It will be noticed that in using waterproofing materials such as felt, in connection with coal-tar pitch or asphaltum, fair results are obtained, when the weather conditions are favorable, and when the work can be done without interference or obstructions by working continuously until completed; it is also noticed that when the work is done at

an unfavorable season, or when work is done in distinct separate periods and sections, under difficulties such as track operations, undue haste in completing the work necessitated by special circumstances, the results have generally been unsatisfactory.

The committee has not prepared a final report on the subject of waterproofing.

Illinois Central.

On a double-track steel viaduct, having through girders with I-beam floor encased in concrete, and deck girder approaches with concrete floor, waterproofing was used to protect the steel. The waterproofing consisted of three layers of felt, one layer of burlap, two layers of felt, a mopping of pitch on the concrete, between each layer of felt and burlap and over all. The work was completed in 1908 and is satisfactory with no leak on the last inspection in October, 1911. The waterproofing was protected by a layer of fine crushed stone and screenings embedded in and covered with pitch. Expansion was provided in the concrete, but no provision for expansion was made in the waterproofing. The cost of the waterproofing, including the protection, was 15 cents per sq. ft.

Central of New Jersey.

On bridge No. 34, central division, leaks appeared along the webs of the main girders during last winter, caused by throwing the snow along the webs of the girders during

G. H. TINKER.

Chairman Committee on Masonry.

the flanging of the tracks. When a thaw set in, the melting snow was held in a pocket in such a manner as to bring the water above the flashing angle and back of the waterproofing. This difficulty has been remedied in later bridges by placing the flashing angle and carrying the waterproofing at least a foot above the top of rail. In this bridge the waterproofing was stopped about on a level with the base of rail.

The cost of 40 cents per sq. ft. includes the furnishing and applying of waterproofing materials and the cost of the protecting brick in place. The cost of the brick was $8.00 per thousand, f. o. b. cars at the work.

Bridge No. 136, central division, Hampton, N. J., was waterproofed November, 1910, with four layers of Barret's specification felt and one intermediate layer of Barret's Tartex, cemented together with Barrett's specification pitch, waterproofing carried to the under side of flange angles of main girders. The cost of waterproofing this bridge, including the brick protection, was $0.273 per sq. ft. No leaks have appeared up to the last inspection of May, 1911.

Bridge No. 9, central division, completed September, 1911, was waterproofed with four layers of Barrett's specification felt and an intermediate layer of Barrett's Tartex, cemented together with Barrett's specification pitch. This was protected by brick laid flat with joints poured with pitch. The cost per sq. ft., including brick protection, was $0.123 for materials and $0.066 for labor. The brick cost $8.00 per thousand, f. o. b. cars at the work.

Bridge No. 218, central division, is a double-track, half-through plate girder structure about 45 ft. long, with I-beam floor encased in concrete, completed November, 1910. For waterproofing, the upper surface of the concrete was given two coats of Hydrex waterproofing paint. As soon as the painting was completed the ballast was placed immediately on top with no protection for the waterproofing. Up to the last inspection of May, 1911, no leaks had appeared. The concrete at the main girders was carried up to the flange angles of the girders which were about 20 in. above the top rail. The painting was also carried to that point.

New York Central & Hudson River.

Mr. George W. Kittredge, chief engineer, furnishes the following information:

Trouble experienced in the case of felt and coal-tar pitch is mostly on account of the poor class of labor used. It does not prevent leakage when the body walls are not built continuously. Trouble is also caused by lack of care in joining successive sections of work, horizontally or vertically.

The subway leading from the Buffalo passenger station is of rectangular section, 20 ft. in width and 7 ft. in height inside, serving 12 tracks. The side walls are of monolithic construction similar to ordinary retaining walls, and the floor is extra thick of the same construction. The roof is of 20-in. I-beams, with concrete filling between, covered with three inches of cement, with waterproofing and with a protection of brick on top of this and under the ballast. The entire outside of the walls was covered with waterproofing consisting of 6-ply tarred felt, each layer put on separately, with Sarco compound, and outside of this the side walls and the top are protected with brick laid in cement. The floor is protected by a 6-in. layer of concrete under the waterproofing, the floor itself above the waterproofing being 10 in. thick, the extra weight being given to prevent floatage, and prevent its being cracked by the upward pressure of the water. The waterproofing of the sides and floor was made continuous as far as possible.

The conditions requiring waterproofing were as follows: This construction is in a bed of clay which extends about half way up the height of the subway, the remaining 6 ft. or so is of a loose gravel, so that all of the surface water coming through the porous matter is held by the clay under slight head.

The construction of this work was carried on under considerable difficulty, it being necessary to work while the traffic, which is very heavy at this point, was going on, and it was possible to build only a part of the subway at a time, and not make a continuous job of it. It is probable that at points where one piece of work left off, and another began, the connection between the waterproofing was imperfect, as cracks began to develop, and the water came into the subway in small quantities in numerous places almost as soon as completed. This was remedied by careful application of ½-in. hydrolithic cement by the waterproofing company, on the inside of the subway, so that the structure is now tight, except the roof, where on account of the vibration of the trains, it was practically impossible to insure an absolutely tight job. Great care was taken to find all cracks, dig them out and fill them with hydrolithic cement. The cost of the hydrolithic waterproofing was about 30 cents per sq. ft., and has now been on for two years, and has given good satisfaction.

Referring to the waterproofing of masonry, I can only add a few remarks in regard to the waterproofing which we found on the old Park Avenue tunnel roof where a portion of it was removed at 59th street.

The roof consisted of iron beams with brick arches which were leveled up with concrete. The waterproofing was placed directly on this concrete and was covered with about two ft. of earth which formed the soil for the parking around the openings in the roof of the tunnel. Drains were provided so that the water did not stand in the earth. The materials were of felt and coal-tar pitch, three plies of felt being used. We have no information as to the method of application or the cost of the work. I have understood indirectly that this waterproofing was placed when the tunnel was built, some forty years ago. From recollection of the tunnel for the past ten years the vegetation over this waterproofing was in such a state that the waterproofing must be at least twenty years old. The waterproofing was removed on account of changes we were making last winter, and it was in fair condition. The paper had become somewhat brittle, also the pitch was harder than pitches we apply now, but the sheet of waterproofing was intact and capable of shedding water. Small leaks would not have been detected; the only protection of the concrete was the soil placed over it. The waterproofing covered the tunnel roof from 58th to 59th street,

and presumably extends a good deal farther. There was no provision for expansion joints.

El Paso & Southwestern.

We waterproofed in 1908 about 194,000 sq. ft. of concrete-lined reservoirs, using the Sylvester process of soap and alum, two coats of each, and by painting the surface with asphalt and Elaterite waterproofing. We depended largely upon this waterproofing for water-tightness, and the concrete was not as rich in cement as it otherwise would have been. Theoretically, the mixture was 1:2:4; actually, some of it was not quite that rich. We had considerable trouble with leakage through portions of the concrete and, upon examination, such parts were generally found to be evidently porous.

After a period of three years we find the asphalt and Elaterite coating to be a pronounced failure on account of peeling off in the winter time through the action of frost. We find the Sylvester process of soap and alum quite efficient. Except in places where the concrete is evidently quite inferior, the soap and alum has made the concrete watertight. Where the concrete was good and the work thoroughly done, the water will stand and roll on the surface of the concrete as it will on plate glass. Of course, the concrete is not actually as impervious as the glass, but drops of water on the concrete so waterproofed disappear by evaporation rather than by absorption.

The sand and gravel used in lining these reservoirs were of a fair grade only, the maximum size of gravel being 1½ in. The concrete lining was from 4 to 6 in. thick. The gravel was not as finely graded as it should have been and the larger stones were evidently too large for that kind of work.

The cost of waterproofing with soap and alum was 0.43 cent per sq. ft.; with asphaltum 1.40 cents, and with Elaterite waterproofing 1.50 cents per sq. ft.

A few months ago we completed a reinforced concrete septic tank 30 ft. in diameter and 12 ft. high, with shell 6 in. thick. No waterproofing was used in this concrete. It was theoretically a 1:2:4 mix, but we actually used a somewhat greater percentage of cement. The sand and gravel were good. The specifications for the gravel required it all to pass through a ½-in. screen. This tank is entirely watertight, except at the joints between successive courses of concrete. It appears to be demonstrative of the possibility of making concrete watertight, at least for the light pressure existing in this particular tank.

First-class sand and stone, carefully graded, to reduce the voids, and a liberal margin of cement in excess of the voids in the sand and stone, and thorough uniformity in the mixing and laying are, we believe, more efficient than anything else in making concrete waterproof. The maximum size of the stone should not exceed ¾-in. and we thing that ½-in. is better.

Norfolk & Western.

In a concrete subway for use of passengers under the tracks at Petersburg, Va., a 6-in. layer of concrete was placed on the area of foundation and upon this concrete against the outer forms 4-in. brick walls were built. On the concrete base and against the brick walls the waterproofing, consisting of a coat of Sarco concrete primer applied hot, a heavy swabbing of Sarco No. 6 waterproofing and 3-ply membrane No 16 Sarco Asphalt felt, was placed. The felt was lapped so that there is at no point less than three thicknesses of felt, each thickness being heavily swabbed with hot Sarco No. 6 waterproofing before succeeding thickness was applied.

The membrane was well swabbed with Sarco No. 6 and while this coat was still hot a layer of 8-oz. burlap was applied, this layer also being swabbed with No. 6 Sarco and a second layer of 8-oz. burlap, breaking joints with the first being laid.

The last layer of burlap when dry was swabbed with hot Sarco.

The concrete walls, floor and steps of the subway were then built against the waterproofing above described.

The concrete subway roof reinforced with steel rails and expanded metal, laid with a crown of 1 in. for drainage, was waterproofed by a mat of two-ply burlap and three-ply felt laid as described for sidewalls, except that the burlap is laid first or on the bottom of the mat. The roof waterproofing is protected from cutting by the ballast by a layer of 1¼ in. of Sarco asphalt mastic applied in two coats of ⅝ in. each, with lapped joints.

This work was done about a year ago and has proved satisfactory. The cost of waterproofing complete was about 50 cents per sq. ft.

Pittsburg & Lake Erie.

Five 40 to 50 ft. four-track half deck and through girder bridges, with floor stringers spaced 15 in. center to center, and the space between floor stringers filled with concrete, have been waterproofed to protect the metal work and also to stop dripping to the street under the bridge.

The waterproofing consisted of Sarco No. 6 waterproofing with 8 oz. open mesh burlap; 1¾ lbs. of 1:2 cement mortar protection over the waterproofing.

On the clean dry surface of the concrete floor was applied a coating of Sarco concrete primer thin enough to penetrate the recesses of the concrete. In some cases when the primer was too heavy, it was thinned with gasoline. After the primer dried (requiring about one hour) a heavy coating of hot Sarco No. 6 waterproofing was applied and while the material was still hot a layer of 8 oz. open mesh burlap was laid.

Location	Character of the Structure Waterproofed	Conditions Requiring Water-Proofing Head of Water, if any	Materials Used	Date Applied / Date Examined	Remarks
Albany.......	Subway under tracks at passenger station.	Surface water	¾-in. asphalt	Ap. 1902 Ex. 1910	Satisfactory as to walls; roof leaked badly; copper sub-roof put in to take care of moisture.
Brewster.....	Coaling station pit..	6-ft. head.....	6-ply tar and Felt	Ap. 1910 Ex. 1910	Leaked badly; repaired by Hydrolithic compound applied by the Hydrolithic company
Buffalo.......	Scajacuada Creek arch, 40-ft. span	Surface water only	½-in. coal tar pitch	Ap. 1908 Ex. 1910	Good; the only leaks showing were in vertical joints
Buffalo.......	Belt Line reinforced concrete arch	Surface water only	Tarred felt coal tar pitch, ½-in. cement mortar	Ap. 1908 Ex. 1910	Satisfactory
Buffalo.......	Belt Line reinforced concrete arch	Surface water only	½-in. coating straight run coal tar pitch	Ap. 1908 Ex. 1910	Satisfactory
Cohoes.......	Reinforced concrete arch, Columbia Street	Surface water only	½-in. plaster of 1:2 cement over 1 layer of tarred felt over ⅛-in. of straight run coal tar pitch	Ap. 1909 Ex. 1910	Satisfactory
Onchiota.....	Concrete arch, 20-ft.	Road bed surface Drainage	⅛-in. coal tar pitch over 1-in of 1:2 Portland cement mortar	Ap. 1906 Ex. 1910	Satisfactory
Poughkeepsie.	Back of retaining walls	For surface drainage	⅛-in. coal tar pitch	Ap. 1908 Ex. 1910	Fairly satisfactory
Poughkeepsie.	Back of retaining walls	For surface drainage	Medusa compound	Ap. 1908 Ex. 1910	Water stained; walls nearly always let water through at horizontal joints where work ends one day and begins next
Rippleton.....	40-ft. concrete arch..	Surface drainage	⅛-in. coal tar	Ap. 1906 Ex. 1910	Very little value; leaks through intrados every 3 or 4 feet
Troy.........	Subway............	4-ft. head.....	¾-in. asphalt protected by brick	Ap. 1902 Ex. 1910	Very satisfactory
Miscellaneous	Retaining walls.....	Ground and surface water behind walls	½-in. coal tar pitch	Ap. 1900 Ex. 1910	Leakage found usually at horizontal and vertical joints where work was discontinued

Waterproofing Results on N. Y. C. & H. R.—1002-1911.

To apply the burlap on the hot Sarco, first it was rolled on a 2-in. round stick and unrolled immediately after applying the Sarco, exercising care to keep it straight and free from folds. The unrolling of the burlap was followed closely by brooming with a rattan broom. This method was followed until three layers of burlap was applied.

On top of the last layer of burlap a heavy coating of hot Sarco was applied. As soon as convenient, after the Sarco waterproofing was applied, a 1¾-in. thickness of 1:2 cement mortar was laid.

The cost of labor was $0.026 per sq. ft. treated and $0.044 for material, making a total of $0.070 per sq. ft. treated for 3 bridges on which complete data were kept.

At two of these bridges no leaks in the concrete roof are apparent. A few rivets in the girders show that at some time water must have passed through the waterproofing.

At another water is dropping slowly at three places, at six other places indications are that water has been dropping at some time and at a few other places in girders indications are that water has passed through rivet holes at some time.

At another, five places at the edges of floor-beams indicate that water has come through and at two of these places it was dropping slowly at last inspection.

At the other a good many leaks show at the edges of floor-beams and girders. Water is slowly dropping through at many of the rivets.

The reason advanced for the unfavorable condition of the waterproofing on these bridges is that the concrete was not allowed to set up naturally, artificial heat having been applied to dry it preliminary to applying the Sarco primer, and in some cases the waterproofing was applied in unfavorable weather conditions. Another reason advanced is that the cement mortar cover may be broken under impact of traffic and the ballast may have cut the waterproofing.

A bridge at Aliquippa has just been completed which was waterproofed in the same manner as those above described but with all conditions favorable for a fair test, such as dry concrete on which to apply the first coat and dry and warm weather during the time the waterproofing was applied.

The Third Street Subway, Aliquippa, Pa., is a ballast bridge, 288 ft. wide, and supporting about 20 tracks. The distance between abutments is 40 ft. and a line of columns supports the floor structure at the center. The floor is made of 15-in. 80-lb. I-beams, 44 ft. long, spaced 15 in. center to center and filled between with 1:3:5 concrete.

The structure is waterproofed with Sarco No. 6 waterproofing, with two-ply of 8-oz. open mesh burlap.

The area covered was 14,000 sq. ft.

Sarco Primer, 151 gals. @ $0.35 per gal.	$ 52.85
Sarco No. 6, 16,200 lbs. @ $35.60 per ton	288.36
Burlap, 1,560 lbs. @ $0.08 per lb.	124.80
Total cost of material	$466.01
Total cost of labor	251.38
Total cost of labor and material	$717.39

Material cost $.033 per sq. ft.
Labor cost $.018 per sq. ft.

The waterproofing was protected by a 1¾-in. cement covering made of 1:2 mortar, the area covered being 13,320 sq. ft.

Sand used, 52 tons @ $0.65	$ 33.80
Cement, 131 bbls. @ $0.85	111.35
Labor	103.00
Total	$248.15

Material cost $.011 per sq. ft.
Labor cost $.008 per sq. ft.

The waterproofing was applied at different times between May and August, 1911, under favorable weather conditions and is in good condition at this date, October 5, 1911.

METHODS OF PATCHING AND REPAIRING PLAIN AND REINFORCED CONCRETE.

The committee was instructed to collect data and prepare a report on "Methods of Patching and Repairing Plain and Reinforced Concrete." A circular letter was sent to members of the association, requesting information on this subject, to which more than one hundred replies have been received.

The various methods may be described as follows:

(1) Wet Method: The surface of the old concrete is thoroughly roughened, cleaned and drenched with water and covered with a cement grout. Then the new concrete is mixed to a sloppy consistency and applied, being held in place till set by forms, as required. From the reports received it appears that many successes and many failures have followed this method. Where it has been successful, that result probably has been due to painstaking care and great expense being employed in the preliminary cleaning and thorough wetting of the old concrete surfaces before the new concrete is applied.

(2) Moderately Dry Method: The surface of the old concrete is thoroughly roughened, cleaned and drenched with water and powdered with cement or painted with cement grout —after which the new concrete is applied and thoroughly tamped against the old surface. Generally, such patches are kept moist by sprinkling them with water for several days. The same comment applies here as to the wet method.

(3) Dowel Method: This is a modification of the two preceding methods and is generally used for other than horizontal surfaces, although it may be applied to the latter. The new concrete may have any consistency to meet the particular conditions or the ideas of the engineer in charge, but usually a fairly wet concrete is used. This method includes drilling holes and setting dowels into the old concrete, with projecting ends to engage into the new concrete. Sometimes steel bars or metal fabric are connected to these dowels to further insure permanency of the patch. This method can be made uniformly successful, but cannot always be applied. Where any considerable mass of new concrete is to be connected to old concrete this is the only safe method to pursue.

(4) Wedge Method: This includes the cutting out of defective concrete in such a manner as to undercut the surrounding good concrete so that the new concrete will be held in place, when set, by the shape of the binding edges of the old concrete. The difficulty of undercutting concrete so as to secure such edges is too great to make this method applicable in ordinary cases, and, except where a considerable depth of new concrete is to be put in, such undercutting could not be successfully done, as concrete cannot be cut so as to leave sharp, clean edges.

(5) Cleaning with Steam: This is a method of cleaning surfaces of old concrete preparatory to putting on a patch of new, or of cleaning the top of a rough concrete floor before applying the "finish coat." The surface of the old concrete is brushed as clean as possible with stiff brushes and then gone over at least twice with a steam jet—an ordinary piece of half-inch gas pipe makes a very satisfactory jet nozzle. This short length of pipe is connected to a steam hose so that it can be readily moved about. The steam is supplied by the boilers of the mixer or hoisting engines. The steam will clean and heat the concrete surface, leaving it perfectly dry, so it is important to thoroughly drench the surface with water after cleaning with steam. In cold weather it is found advantageous to use hot water. Immediately after the surface is thoroughly cleaned and drenched, the new concrete is applied. Excellent results have followed the use of this method of cleaning, but it is essential that the surface of the old concrete be thoroughly drenched with water after using the steam jet, otherwise the new concrete will not adhere to the old.

(6) Cleaning with Acid: This method includes washing of the surface of the old concrete with a solution of hydrochloric (muriatic) acid (one part acid to two parts water), after which the surface must be carefully and thoroughly washed to remove any free acid. This is a very commonly applied method of cleaning old concrete surfaces preparatory to placing new concrete against them, and, by many, is considered the only safe one to use, especially where a "finish coat" is to be put on after the concrete base is set.

Among the replies to the letters are the following:

L. W. Walter, cement inspector, Erie: "The practice of tamping mortar against old concrete surfaces to fill voids caused by air bubbles, or to finish a surface honeycombed or made rough by scabbling, is one which I would personally recommend, as I have tried it under varying conditions and have not had a failure. In tamping mortar to rough surfaces I would proceed in the following manner: Working downward from the top of the area to be treated I would remove all loose particles and would wash the surface of the old concrete with a brush. The sand and cement for use in the mortar should be the same kind and proportions as that used in the concrete, provided it be not richer than 2½ parts of sand to one part of cement, and should be thoroughly mixed dry and water added by sprinkling until a semi-plastic consistency is had. In tamping the mortar against the surface to be treated, I would work downward from the top of the area in order that the water used in wetting the surface of the concrete would not run down over the newly applied coat. When the surface has been brought to the proper plane, it should be floated with a wooden float, and only such amount of water should be used in the final floating as may be necessary to produce a dense surface. This water may be applied by means of a brush or by dipping the float in water.

"It is found in practice that a rather dry mortar, such as may be tamped, and not plastered, on a concrete surface, is less apt to loosen from contraction and expansion due to temperature changes and will more nearly resemble, in color, the adjoining natural surface.

"In such work as renewing the top or wearing surface which has loosened from the base of concrete pavements, on account of its having been placed after the base had set, the tamping process is a success. It is necessary, however, that the base of the concrete be firm, and advisable that the base be washed with a neat cement wash and the new top be well floated. This, in my opinion, is the most difficult patch work to be encountered and is the best argument I have to offer in favor of using, for patch work, a relatively dry mortar.

"For patching honeycombed surfaces I would recommend

tamping to the exclusion of the old practice of plastering."

H. Rettinghouse, division engineer, Chicago & Northwestern: "I have had several cases, when horizontal surfaces, especially bridge seats, have been damaged by frost, to a depth of from 4 to 8 inches. After removing the frozen and spoiled concrete, we chipped the surface down to a nearly uniform level, equal to the deepest frozen spot. In one case which I have in mind, the entire bridge seat of a three track bridge had been severely damaged by frost. We placed dowel pins in squares of 2 ft., securely anchoring them in the sound concrete, then carefully and thoroughly cleaned and washed off the entire surface and placed new concrete. Recent inspection indicates that work of this kind is an entire success.

"During the past three years, we have successfully jacketed with concrete, old masonry, which had badly deteriorated. The method pursued was the use of hook dowel pins and expanded metal, the jackets varying from 10 to 14 in. in thickness. We took great care to remove all deteriorated and loose portions of masonry, cleaning out joints, etc., and have been entirely successful in securing a perfect adhesion of concrete jackets to the old masonry, so much so, indeed, that we are gradually treating all our more or less deteriorated masonry of bridges on the Iowa division in this manner. We have, unfortunately, a great deal of poor stone in bridge masonry. Some years ago, before I came to this territory, there had been a great many back walls of bridges built up with from 4 to 8 in. of concrete on top of old masonry, on account of track being raised by ballasting. In all of these cases no dowels were used and the method proved a failure."

E. B. Temple, assistant chief engineer, Pennsylvania Railroad: "At South Fork, Pa., we built a retaining wall in the winter of 1909-1910. The weather was unusually severe, and before the concrete set properly the surface concrete was frozen. In the spring, the face of the wall showed signs of disintegration; and, after a careful examination, it was decided to remove as much as possible of the faulty concrete. This was done by picking the surface with a small hand pick to a depth varying from 1 to 18 in. The body of the wall thus exposed was good substantial concrete, and was carefully cleaned. Dowels of steel were driven into this surface, the dowels being placed about 6 in. apart, and to these dowels a light reinforcing mesh wire was firmly attached. The forms for the face of the wall were then placed; and, after the concrete had been thoroughly wet, the forms were carefully backfilled with a cement and sand in the proportion of approximately 1 part cement to 2 of sand. This wall has been standing for about fifteen months, and apparently is in as good condition to-day as when put in place."

G. J. Ray, chief engineer, Delaware, Lackawanna & Western: "The only extensive job which we have had to contend with was a concrete bridge consisting of several 33-ft. arches. The concrete in this structure showed signs of either poor cement or acid bearing water used in making the concrete, with the result that it scaled off in large quantities every year. It was an easy matter to dig down into the solid concrete, but if the solid concrete was exposed for any length of time it again would start to deteriorate. The entire structure was repaired by covering it completely with from a foot to 18 in. of reinforced concrete, the new concrete being bonded to the old by a large number of dowel pins, which were drilled into the old concrete and fastened in a substantial manner. This repair job has proved to be very satisfactory. To make the work permanent the entire outside of the old structure was excavated and properly waterproofed."

Conclusions.

The committee presents the following conclusions as to the methods of repairing defective or worn surfaces of concrete:

(1) In all cases the surface to be repaired must first be thoroughly cleaned of all loose material, laitance and dust and the clean, rough, sound concrete exposed to receive the patch. Probably the best method of cleaning is by means of a steam jet.

(2) After cleaning, the surface to be repaired must be thoroughly saturated with water, not simply moistened, but so thoroughly drenched that the old concrete will not absorb water from the new mortar or concrete used in patching. If possible, the surface should be kept covered with water for several hours.

(3) If the repair or patch is to be made on a vertical or sloping surface and is not to be more than 1½ in. thick, the surface of the old concrete, while it is still wet, should be spattered or splashed with a cement grout, following this immediately with a fairly stiff plaster coat of mortar made of the same proportions of cement and sand as was used in the original concrete, but never richer than 1 cement to 2½ sand. This plaster coat should not be thicker than ½ in. and each coat should be forced into the surface, but not dragged with a trowel. The surface of each coat, except the final coat, should be "scratched" to give a bond for the next coat. This plastering should preferably begin at the top and progress downward, and only enough time be allowed to permit each coat to receive its initial set before the next coat is applied. The final coat should be finished with a wooden float and only enough water used to properly finish the surface. This patch should be kept damp and protected from sun or frost till fully set up.

(4) If the repair or patch or "finish coat" is to be made on a horizontal or nearly horizontal surface, the surface of the old concrete should be slushed and broomed with a thin cement grout, following this immediately with a wet mortar made of 1 part cement and 2½ parts sand or granite screenings and of the full thickness required (not less than ½ in. thick, however). When this mortar begins to take its initial set, it should be floated or troweled to such a finish as may be desired.

(5) If the repair or patch is to be made on a vertical or sloping face and is to be more than 1½ in. thick, it will be advisable to embed dowels into the old concrete, as deeply as the thickness of the proposed patch, and spaced sufficiently close together to firmly anchor the patch to the old concrete. The dowels must be wedged into the old concrete and it will be advisable to fasten wires, metal fabric or bars to the dowels, in the case of extensive patching, as an additional safeguard. The patching may then be done with mortar without forms, or with wet concrete supported by forms, depending upon the thickness and the extent of the patch.

(6) If the repair or patch is to be made on a horizontal or nearly horizontal face and of considerable thickness, dowels may be used, or the concrete may simply be reinforced by fabric or bars without using dowels—treating the patch as a block of masonry.

(7) Care must be taken not to have thin edges on patches. To avoid this, it may be necessary to cut out sound concrete around a place to be patched, so as to give deep edges to the patch. If possible, the edges should be undercut.

METHODS OF DEPOSITING CONCRETE UNDER WATER.

Letters and circulars of inquiry were sent to the members of the association, requesting information on the subject of "Methods of Depositing Concrete Under Water." This inquiry embodied the following questions:

(1) Methods used for depositing concrete.
(2) Depth of water.
(3) Results.
(4) Precautions necessary to secure desired results.
(5) A statement of the cost of plant and relative cost of depositing concrete per cubic yard, as compared with concrete deposited by the usual methods, will be of value in this investigation.

Of the 71 replies received, 56 contain information of value, covering nine methods of depositing, viz., bottom-dump bucket, tremie or closed chute, sacks, sacks withdrawn, paper bags, open chutes, open depositing, pneumatic grouting of broken stone, concrete blocks. The following extracts are from the replies received:

W. H. Courtenay, chief engineer, Louisville & Nashville: 1a. A large number of piles in sea water were protected from attack by teredo by covering the submerged portions of piles with concrete 2 to 4 in. thick. Forms were placed around the piles and then the concrete was deposited by pouring it through a tube. b. A bridge pier, built many years ago, was partially undercut by the river, and an attempt was made to fill the space vertically under the pier with concrete. The concrete was mixed moderately dry, and poured through an 8-in. wrought iron pipe from the track level. c. For a bridge foundation recently constructed in 30 ft. of water, the cofferdam was first built of steel piles. Wooden bearing piles were then driven within the cofferdam and cut off at the level of the river bed. The material around these piles was then excavated to a depth of about 4 ft. with centrifugal pumps, and then about 4 ft. of concrete deposited between heads of the piles by running it through iron pipes, the idea being to place a 4-ft. depth of concrete around the piles before attempting to pump out the water from within the cofferdam, for, on account of the nature of the bottom, it was not feasible to pump the water out otherwise. 2a. Water ranged from about 18 ft. down. 3a. Successful. At times, however, mud at the bottom of the

forms became mixed with concrete, greatly impairing the strength of the concrete. Upon examination by a diver, some of this concrete was found to be good and some bad. 3b. During the progress of this work, the surface of the water within the cribs was at all times covered with a thick foamy scum. This work was constructed 20 years ago, and has given no trouble. 3c. After this concrete had been deposited and set, an effort was made to pump out the interior of the cofferdam, which was not successful. Examination by a diver disclosed the fact that the concrete in one spot of limited area was inferior in quality, and the water pressure was such as to create a blowout through this inferior concrete. The poor concrete was excavated by a diver, and good concrete substituted, by lowering it in bags and having it placed by a diver, after which the water within the dam was pumped out, and the remainder of the pier constructed. 4. Although, as a general proposition, it would seem that concrete can be deposited under water at less cost than would be necessary for constructing water-tight cofferdams, and pumping the water out of the foundation before concrete is placed, the experience of the writer leads him to believe that it is generally unsatisfactory and should not be resorted to if foundations can be pumped out at reasonable cost.

A. C. Everham, assistant chief engineer, Kansas City Terminal: 1a. At Detroit, Mich., in the construction of the Detroit River Tunnel, there was deposited about 100,000 cu. yds. of concrete through tremie pipes, the concrete being mixed upon a scow and poured in tremie, the lower end of which was always kept embedded in the soft concrete or in the mud at the bottom of the river. The concrete was placed around the steel tubes which formed the waterproofing of the tunnel and was retained by cross partitions and a wooden form on the outside of the tubes, thus forming a "pocket" which permitted the concrete to set with minimum of disturbance. The mass of concrete for the enclosed tube was about 56 ft. wide at the top, about 32 ft. deep, and, when under water, about 40 ft. below water level. On account of the pockets and lower end of the tremie pipe always being in soft cement, there was little, if any, disturbance of the cement in the concrete. 1b. In Toledo, Ohio, last year there was built by the C. H. & D. an ore dock of reinforced concrete, supported on piles, the lower 3½ ft. of which was deposited in water. Concrete was mixed on a scow and carried by pipe from hopper to point of deposit. The first few batches were deposited in the open water without protection, and possibly some of the cement was lost. 3a. The character of the concrete was ascertained as nearly as possible by taking samples with a calyx drill and obtaining a great many cores, from which several were selected at random and submitted to compression tests in the crushing machine. Of four cores taken thus at random, the concrete being a 1:2:3 mixture, there was found an average crushing strength of 3,239 lbs., the maximum being over 4,000 lbs. In order to compare this concrete with concrete placed under normal conditions in retaining walls, some cores were taken from a retaining wall at Detroit with same grade of concrete. Of four samples, the average was 2,320 lbs., as against 3,239 lbs. of the four samples deposited by tremie. 3b. On examination this concrete was shown to be of excellent quality.

E. B. Temple, assistant chief engineer, Pennsylvania Railroad: 1. Last year there was successfully constructed a truss bridge across the Schuylkill river in connection with the Philadelphia terminal improvements, where was deposited concrete under water for four piers of the bridge. The method pursued was as follows: A cofferdam of 12 in. by 12 in. timbers was built near the shore and sunk at low tide on the site of the pier. All possible excavating was open at the bottom, was placed, a suction hose was used the rock foundation was cleaned as thoroughly as could be done by dredging. After the box, which, of course, was open at the botom, was placed, a suction hose was used to remove material that could not be taken out by the bridge, or that drifted into the tide during the setting of the box. The bottom was also carefully examined by divers. Concrete was then deposited by means of a bottom dump bucket, with a cover on top. The bucket was lowered carefully to within 2 ft. of the bottom, and after resting a moment the bottom was released and the concrete gradually settled into place. The top of the concrete was kept as level as possible by having the buckets dumped uniformly over the entire surface. This concrete was carried up to within 2 ft. of low water and allowed to set for at least a week before the cut-stone piers were started. 1b. A bridge was constructed, in 1902, over the Schuylkill river in about the same depth of water as the one above referred to, by the usual method of pumping out the dam, so that the concrete could be deposited in the open air all the way down to the rock. Several months were consumed in the attempt, and finally from about 6 to 8 ft. of the foundation had to be constructed under water, as it was impossible to keep the dam tight at the bottom and pump out all of the water. 2. The water in the deepest pier was 40 ft., and no trouble whatever was experienced in this method of construction. 5. The cost of a plant for depositing the concrete in this way would practically be the same as for depositing it in the open air. The stone and sand were brought to the site on scows, and the concrete mixer and derricks were also on floating equipment. With such a plant, and following the usual method of pumping out the cofferdams before depositing the concrete under water, the cost would be about $25 per cu. yd. By depositing the concrete, as done in this case, the cost averaged about $21 per cu. yd. These, apparently high prices include excavation or dredging, cofferdams and all cost in connection with the operation.

Job Tuthill, assistant engineer, Kansas City Terminal: 1a. Filled 8 ft. in bottom of a circular sheet pile crib with a cubical box having bottom in halves, hinged to the sides. Box closed and handled with load by one rope, and placed where concrete was wanted, then box dumped by second rope similar to the way orange peel buckets are handled, and pulled in. 2. Fourteen feet. 3. Very satisfactory. The concrete was nearly level and spread out against sides of crib when pumped out. 4. Handle carefully. After the steel tubes forming the river section of the La Salle Street tunnel under Chicago river had been sunk in place, it was necessary to construct a cofferdam at each end of the tubes, behind which the water could be pumped out, permitting connections to be made to the land sections. At each end of the river section there was a timber crib 11 ft. wide, securely fastened to the tubes and reaching 3 ft. above the surface of the river. From the ends of these cribs, pockets, approximately 17½ ft. square, were formed by driving Friestedt steel sheeting of from 50 to 65 ft. in length. Within these pockets the depth of water ranged from 45 to 53 ft. On account of this extreme depth, it was not deemed advisable to fill the pockets entirely with clay, but to fill the bottom with concrete to a depth below water level of about 37 ft., and in the same operation fill the space between the shell of the tubes and the bottom of the excavation. An attempt was made to deposit concrete by the tremie method, by use of a 12-in. diameter pipe, permitting the concrete to spread from the bottom end of the pipe. This method did not prove successful on account of the difficulty of keeping the tremie full of concrete, and the difficulty of manipulating it in this depth of water. An examination by diver indicated a considerable segregation of the sand and stone so this method was abandoned.

The following method was then determined upon: Gas pipes, 1½ in. diameter, were bent to the radius of the tunnel tubes and placed so that they would discharge at varying distances underneath the tubes. Four of these pipes were placed in each pocket and rigidly fastened in position by divers. These pipes did not have well points attached to the ends. In addition to the bent pipes, each pocket contained 12 to 15 2-in. diameter pipes, equipped with well points, stripped of the netting, at bottom ends, and placed so as to be about 2 ft. above the bottom of the excavation. The top end of all pipes was threaded for attachment to the grouting machine. About 5 ft. of broken stone was then spread over the bottom of the pocket and grout under a pressure varying from 35 to 100 lbs. per sq. in. was forced through the pipes to fill the voids in the layer of stone.

In general, the grout consisted of a mixture of about five bags of cement to one barrow of torpedo sand. All lumps, gravel, etc., which would clog the well points, were removed from the cement and sand before mixing. The grout was thoroughly mixed before being put into the McMichael's compressed air mixer. After placing the bottom course as above, a second set of pipes and another layer of broken stone were placed and grouted as before. This process was continued until the desired height of concrete was obtained. This method made use of quite a large number of pipes, as it was impossible to remove them after the grouting was complete. The method used in the south cofferdam was similar to that used in the north, except that in the main section of the pockets, only one set of pipes was used. After these had been put in position, the whole volume of broken stone was deposited. Grout was then forced through the pipes, and as the grouting continued, the pipes were worked up and down through the mass of stone until the voids were filled. This method appeared to be as successful as that used in the north dam, although about

three hundred bags less of cement were used. During the operation of grouting, whenever the grout was flowing freely into the voids, the pressure was from 40 to 50 lbs. per sq. in., but when the voids were practically filled, this pressure became 90 to 100 lbs. The operation at all times continued until no more grout could be forced into the pipes. After the concrete had sufficiently set, the remaining volume of the pockets was filled with clay; the north dam proved in all respects securely water-tight, leaks were slight, and the water apparently flowed along the line of separation between the clay and the concrete. In the south dam, one bad leak developed, the water apparently coming from the river underneath the concrete.

Conclusions.

(1) Concrete may be deposited successfully under water, if so handled as to prevent the washing of the cement from the mixture.

(2) Cofferdams should be sufficiently tight to prevent current through the pit, and the water in the pit should be quiet.

(3) The concrete should be deposited in place either by means of a drop-bottom bucket or a tremie, and should not be allowed to fall through the water.

(4) Where a bucket is used, it should be carefully lowered to the bottom and raised to the surface, so as to cause as little disturbance as possible of the water.

(5) Where a tremie is used, it should be kept filled with concrete up to the water level, and the discharge end should be kept buried in the freshly deposited mass to prevent emptying, and raised a few inches at a time as the filling progresses.

(6) The surface of the concrete must be kept as nearly level as possible to avoid the formation of pockets which will retain laitance and sediment.

(7) Where concrete is not deposited continuously, all sediment should be removed from the surface of the concrete, by pumping or otherwise, before depositing fresh concrete.

(8) The concrete should be a 1:2:4 mixture and of a "quaking" consistency.

(9) Freshly deposited concrete should not be disturbed.

(10) Where the flow of water through the pit cannot be prevented, concrete should be deposited in cloth sacks.

UNIFICATION OF PORTLAND CEMENT SPECIFICATIONS.

Early in the year 1911 two Government boards or committees were appointed to deal with the question of cement specifications. One of these, appointed by the chief engineer of the United States Army, was instructed to revise Professional Papers No. 28; the other was made up of representatives from the various departments, appointed by the head of each department. This committee was instructed to prepare and report to the departments a single standard specification for the Government. This body was known as "The Departmental Committee for the Unification of Government Specifications for Portland Cement."

On September 12 the Army board held a meeting at which representatives from the various engineering bodies interested in cement specifications, from the Association of American Portland Cement Manufacturers and representatives from one or two commercial laboratories, were in attendance. At this meeting the Army board received suggestions for the revision of Professional Papers No. 28.

Following this meeting the departmental committee issued a tentative specification, which was sent out with request for criticism and suggestion.

On November 24 a meeting was held at Washington which was attended by representatives from the departmental committee, the Army board and the American Railway Engineering Association. Committee C-1, American Society for Testing Materials, and Committee on Uniform Tests for Cement, American Society of Civil Engineers, were not represented, though they had previously accepted the invitation to be present. It was apparent that the tendency of the departmental committee was to adhere quite closely to the standard adopted by the American Society for Testing Materials, which is also the standard of this association.

On November 27 a meeting was held in Philadelphia, attended by representatives from the Committee on Uniform Tests for Cement, American Society of Civil Engineers, Standard Specifications for Portland Cement (C-1), American Society for Testing Materials, and through its membership on Committee C-1 this association was represented. The Association of American Portland Cement Manufacturers and the departmental committee were also represented. The principal question before this meeting was that of uniform methods, and an agreement was reached on every point excepting the use of the Vicat needle vs. Gilmore needle in determining time of set, and Vicat needle vs. ball test in determining normal consistency.

On January 8, 1912, representatives from the departmental committee and Committee on Uniform Tests for Cement of the American Society of Civil Engineers met with the Army board to further consider the points of difference in the respective specifications. Agreement had been reached upon all points excepting those previously mentioned, and at this meeting the representatives of the American Society of Civil Engineers expressed preference for retaining the Vicat needle, but offered to compromise and accept the ball method as the means of determining normal consistency if the Government representatives would accept the Vicat needle as the method of determining the time of set.

After due consideration the Government representatives were convinced that the Gilmore needle should be retained in their specifications; also, that the ball test for determining normal consistency is preferable to the Vicat needle, and a specification which agrees with the standard of this association in other particulars was approved by the departmental committee and the board of engineer officers and recommended for adoption as a United States Government standard specification for Portland cement.

The Committee on Uniform Tests for Cement, upon making their report to the American Society of Civil Engineers in January, stated that they had been unable to get together with the Army board and the departmental committee on methods of tests, and, considering their work finished, asked to be dismissed. The committee was accordingly relieved from further duty.

CONCLUSIONS.

The committee recommends:

(1) That the conclusion in reference to "Methods of Patching and Repairing Plain and Reinforced Concrete" be approved as good practice.

(2) That the conclusions in reference to "Methods of Depositing Concrete Under Water" be approved as good practice.

The report is signed by G. H. Tinker (N. Y. C. & St. L.), Chairman; F. L. Thompson (I. C.), Vice-Chairman; G. J. Bell (A. T. & S. F.), H. E. Boardman (M. P.), C. W. Boynton (Universal Port. Cem. Co.), T. L. Condron (Consulting Eng.), L. D. Crear (Erie), L. N. Edwards (G. T.), A. H. Griffith (B. & O.), L. J. Hotchkiss (C. B. & Q.), Richard L. Humphrey (Consulting Eng.), W. H. Petersen (C. R. I. & P.), Philip Petri (B. & O.), J. H. Prior (C. M. & St. P.), F. E. Schall (L. V.), G. H. Scribner, Jr. (Contracting Eng.), A. N. Talbot (Univ. of Illinois), Job Tuthill (K. C. T.), A. A. Wirth (P. L. W.).

Discussion on Masonry.

P. C. Newbegin (B. & A.): Referring to Conclusion 4 as to the methods of repairing defective or worn surfaces of concrete, I ask why in one case the committee recommends mortar of the same standard as the original structure and not in the other?

Mr. Tinker: There is no very good reason for the difference there, except that in both cases a very rich mortar is not successful. It cracks too much. Therefore, we limit it to 1 : 2½. In the case of horizontal surface there is not the tendency for the mortar to fall off that there is on a vertical surface. There is less cracking and less shrinkage if the two mortars are of the same consistency.

A. W. Carpenter (N. Y. C. & H. R.): Does paragraph 6 refer to cracks more than 1½ in. thick? The preceding paragraph refers to a patch more than 1½ in. thick, but paragraph 6 does not give any definite thickness.

Mr. Tinker: This refers more especially to a rather thick block of concrete, in the nature of a replaced bridge seat, which might be from 6 in. to 2 ft. thick. In that case it is a little more than a patch.

E. V. Smith (B. & O.): I notice that in paragraphs 5 and 6 there is no mention of the size of the dowel or the number of dowels to be put in.

Mr. Tinker: That would be regulated by the size of the patch, and the only method to determine that would be to consider the cross section of the patch and the amount of shrinking stress which could be obtained and placed dowels enough to withstand this stress.

Mr. McDonald: I want to know if the committee has made any investigation of the different patented methods that are being so extensively advertised. I refer especially to one which seems to be a modification of what is known as the old rust joint. A mixture of about 48 parts of iron filings, 48 of Portland cement and 2 of sal ammoniac has been patented, and the manufacturers are endeavoring to sell it at the rate of five cents a pound.

Mr. Tinker: The committee has not considered definitely

mixtures of that kind. It is the tendency of the committee to frown on patented mixtures. The mixture to which Mr. McDonald has referred is in the nature of a foreign substance which is placed upon the concrete. It is not strictly a patching of the concrete. There are a number of substances which can be made to adhere to the surface of the concrete and produce a different finish. There are a number of substances which will make a more or less ornamental finish on a concrete floor, for instance, but it is not strictly a patch upon the concrete. The idea of a patch is that of a concrete surface which is either imperfect or broken, and which must have its surface restored, by putting a patch of concrete upon it.

This particular mixture is about one-half Portland cement, about one-half iron filings and a small percentage of sal ammoniac, all comparatively cheap materials, and it is being sold at five cents a pound. This cost figures out about 15 times the cost of Portland cement by the pound. That is one reason why we did not consider it. The cement is plenty good enough.

Mr. McDonald: I did not know that the committee expected this section to be confined to the method of patching concrete with concrete. If they are convinced that they have arrived at the best method of patching concrete, and the plan they propose will work in all cases, then the committee's report is all right. On the other hand, if there are patented methods of patching worn places in concrete surfaces that are superior to the method recommended by the committee, I think we ought to know it, whether they are patented or not.

L. G. Curtis (B. & O.): I inquire if the committee has made any use of what is known as Ransomite for the preparation of the surface of concrete before the application of the new surface is made. The B. & O. has used a great deal of it, and has had good success with it, so far as my information and experience goes.

Mr. Tinker: In the abstracts of the replies to our circular which we give in the report, there will be found a number of methods recommended for preparing the surface of the concrete, one of which is the acid method, which is a good method. That is what the Ransomite mixture is. The committee recommends, as the best method, the use of a steam jet.

The seven conclusions as to the methods of repairing defective or worn surfaces of concrete were adopted as presented by the committee.

Mr. Lindsay: Does section 3 of the conclusions as to depositing concrete under water exclude all methods except the drop-bottom bucket and the tremie?

Mr. Tinker: It does not exclude the other methods. There are instances where the other methods may be used; but we do recommend, from the information received, especially for a work of magnitude, that these two methods are preferable. One of these methods may be preferred in one case and the other method in another case.

R. D. Coombs (Con. Eng.): Is it necessary to specify the exact mixture in No. 8, and would it not be possible in some cases to use a leaner mixture?

Mr. Tinker: It is undoubtedly true that concrete of a leaner mixture might be successful. The danger with concrete under water is that a slight current will remove the cement if it has an opportunity to wash through it, and for that reason it should be a fairly rich mixture. The committee thought 1: 2:4 was fairly rich, and perhaps not too rich.

The ten conclusions as to depositing concrete under water were adopted as presented by the committee.

A motion that the conclusions adopted be printed in the manual was carried.

RECORDS AND ACCOUNTS.

The following work was assigned for the year:

(1) Make a comprehensive study of the forms in the manual which were adopted a number of years ago.

(2) Study the economical way of managing a storehouse so as to assure a minimum stock of materials at all times.

(3) Make concise recommendations for next year's work.

The committee devoted by far the greatest part of its time to subject 2, the first point discussed relating to the scope of the instructions as follows: Should the internal economy of the storehouse be solely considered, or should the effects of storehouse management on the broader economies of maintenance and operation be also taken into consideration? As the first involves a storekeeping rather than a maintenance or operating problem, the committee decided to base its investigation and report on the second interpretation.

Material and labor are required in the construction, maintenance and operation of railways; and since it is impossible to secure materials when, and in the quantities required, by direct purchase, a reserve stock is accumulated which is drawn upon to meet the demands as they arise. The following figures are taken from the report of the Interstate Commerce Commission for the year ending June 30, 1909:

Operating expenses of the railways of the United States for the year ending June 30, 1909, amounted to $1,599,443,410.

Machinists, carpenters, other shopmen, section foremen, other trackmen, other employes and laborers, whose efficiency depends to a great extent on their having proper materials and tools, received in wages $466,138,215, or about 29 per cent. of the entire operating expenses.

The general balance sheet for the same period gives the value of materials and supplies on hand at $206,849,619. Five per cent. per annum on this sum is $10,342,481, about 2.2 per cent. of what was paid during the year to the classes of employes above mentioned.

Assuming that it is possible to reduce the stock on hand to the extent of 50 per cent., the saving per annum would be only 1.1 per cent. of the amount paid annually in wages to the above mentioned employes, so that even a slight loss in their efficiency through failure to secure materials and tools as required, will soon absorb much more than the amount saved by reduced investment in stock. It would seem, therefore, that the most important function of a storehouse is the prompt delivery of materials and tools so that delays to labor resulting from their lack may be reduced to a minimum.

H. J. PFEIFER.

Chairman Committee on Records and Accounts.

CONCLUSIONS.

It is recommended—

(1) That no changes be made in the forms appearing in the manual.

(2) That the following statement embodies the general principles governing the economical management of a railway storehouse:

Reasons for Maintaining a Storehouse.

The object of a storehouse is to provide material and tools when required so that the cost of work may be a minimum, bearing in mind the factors of delay to work or labor, also interest on investment in stock.

The following essential elements enter into the problem:

(a) Standardization.—The standardization of materials and instructions in regard to their use will reduce to a minimum the number of items of material of the various classes which should be carried in stock. The amount of each item which should be carried in stock will depend upon the rate of consumption, time required for the purchase and delivery of material, and also upon local conditions.

(b) Classification of Material.—This is necessary so as to reduce to a minimum the cost and time of handling. An approved classification should be followed in making requisitions.

(c) Stock Account.—An account should be kept of stock showing at all times a record of receipts, disbursements and amount on hand. Stock should be replenished when the amount of any item has been reduced to a fixed minimum. Inventories should be made at stated periods. A proper stock account furnishes a check on excessive supply and obsolete material.

(d) Distribution.—When material is shipped, notice should

be sent to consignee showing partial or complete filling of requisition and if partial, when final shipment may be expected.

(e) Organization.—The storekeeper's place in the general organization should be so fixed and adjusted that the measure of his efficiency is, primarily, the promptness and accuracy with which he fills requisitions, and, secondly, his ability to hold down the stock investment to the lowest amount consistent with the first requirement.

The report is signed by H. J. Pfeifer (St. L. Term), chairman; M. C. Byers (St. L. & S. F.), vice-chairman; J. M. Brown (C. R. I. & P.), Edw. Gray (Southern), E. E. Hanna (M. P.), Henry Lehn (N. Y. C. & H. R.), J. H. Milburn (B. & O.), C. W. Pifer (I. C.), Guy Scott (P. L. W.), W. A. Christian (C. G. W.), G. J. Graves (A. T. & S. F.), C. W. Cochran (C. C. C. & St. L.), G. T. Warren (B. & O.), H. Stephens (L. S. & M. S.).

The conclusions and the matter under "Reasons for Maintaining a Store House" were adopted as presented without discussion.

ELECTRICITY.

The outline of work for 1911 was as follows:

(1) Continue the consideration of the subject of clearances.

(2) Continue the preparation of standard specifications for overhead transmission line crossings.

GEORGE W. KITTREDGE.
Chairman Committee on Electricity.

(3) Report on effect of electrolytic action on metallic structures and best means of preventing it.

(4) Method of insulation and protection.

In accordance with instructions the committee has confined itself to the following subjects:

(1) Clearances.

(2) Transmission lines and crossings.

CLEARANCES.

At the last meeting of the association, at which our report was considered, it was decided that in view of the fact that the American Railway Association had a Committee on Clearance Lines and the American Electric Railway Engineering Association also had a Committee on Clearance Lines, and because of the fact that the Committee on Electricity had not been able for various reasons to reach conclusions with them to accept the report on clearance as one of progress only, with the idea of agreeing with the other associations mentioned prior to the next meeting.

The chairman of the Sub-Committee on Clearances has subsequently been in communication with representatives of the committees of the other two associations mentioned, with the result that diagram "A" is now submitted as the recommended clearance for equipment and permanent way structures adjacent to third rail and for third rail structures.

It is believed that similar diagrams will be recommended to the American Railway Association by the Committee on Electric Working and by the committee considering the subject of Clearance of the American Electric Railway Engineering Association.

Diagrams have been obtained from all the principal railways in the United States using third rail, showing outlines of their third rail structures and from some of the principal steam railways diagrams showing outlines of maximum equipment. These various diagrams were used as a basis in establishing clearance lines for third rail structures, permanent way structures adjacent to third rail and equipment.

A table is also given showing "Data Regarding Third Rail Clearances," which has been prepared from information recently received from various companies with a view of ascertaining what proportion of track mileage, of roads using both steam and electricity, will clear the recommended clearance lines. From an inspection of this table it will be noted that out of a total mileage of 1,988.04 using steam and electricity, 973.80 miles will clear. It will also be noted that the mileage not clearing is mainly interurban electric roads which handle steam equipment as secondary traffic and elevated roads in cities which do not handle steam equipment.

At the last meeting of the Association the definition for "Third Rail Gage," as follows, was adopted:

"Distance, measured parallel to plane of top of both running rails, between gage of running rail and center line of third rail."

It is now proposed changing the definition to read as follows:

"Third Rail Gage.—Distance measured parallel to plane of top of both running rails between gage of nearest running rail and inside gage line of third rail."

TRANSMISSION LINES AND CROSSINGS.

The sub-committee chairman has been working in conjunction with committees of the National Electric Light Association, American Institute of Electrical Engineers, American Electric Railway Association, Association of Railway Telegraph Superintendents, and representatives of the telephone and telegraph companies, in connection with the preparation of specifications for overhead crossings of electric light and power lines, and the accompanying specification is submitted which is identical with the specifications that have been adopted by the other associations mentioned, excepting in paragraphs Nos. 10, 13, 18, 24, 29, 31, 32, 34, 45, 49, 51, 55, 60 and 61, which changes are in line with more clearly expressing the condition or of making them more satisfactory from the point of view of the railways. For the convenience of the members the paragraphs mentioned are given as Appendix "B" to this report in the form in which they have been adopted by the other associations mentioned above.

CONCLUSIONS.

(A) The Committee recommends for adoption by the association:

(1) Definition: "Third Rail Gage.—Distance measured parallel to plane of top of both running rails between gage of nearest running rail and inside gage line of third rail."

(2) The lines shown on diagram "A" as equipment clearance lines.

(3) The lines shown on diagram "A" as permanent way structure adjacent to third rail clearance lines.

(4) The lines shown on diagram "A" as third rail structure clearance lines.

(5) The adoption of the specifications for overhead crossings of electric light and power lines.

(B) The committee recommends a continuation of work already outlined, particularly consideration of clearance for overhead third rail working conductors, electrolysis and insulation and the consideration of any new information that may develop in reference to maintenance organization and relation of track structures, and asks for such other direction or instructions as seem necessary or desirable.

The report is signed by George W. Kittredge (N. Y. C. & H. R.), chairman; J. B. Austin, Jr. (L. I.), vice-chairman; R. D. Coombs (Consulting Eng.), A. O. Cunningham (Wabash), L. C. Fritch (C. G. W.), George Gibbs (P. T. & T.), G. A. Harwood (N. Y. C. & H. R.), E. B. Katte (N. Y. C. & H. R.), C. E. Lindsay (N. Y. C. & H. R.), W. S. Murray (N. Y. N. H. & H.), J. R. Savage (L. I.), W. I. Trench (B. & O.), H. U. Wallace.

APPENDIX A.

SPECIFICATIONS FOR OVERHEAD CROSSINGS OF ELECTRIC LIGHT AND POWER LINES.

General Requirements.

Scope.

1. These specifications shall apply to overhead electric light and power line crossings (except trolley contact wires), over railroad right-of-way, tracks, or lines of wires; and, further, these specifications shall apply to overhead, electric light and power wires of over 5,000 volts constant potential,

crossing, or constructed over telephone, telegraph or other similar lines.

Location.

2. The poles, or towers, supporting the crossing span preferably shall be outside the railroad company's right-of-way.

3. Unusually long crossing spans shall be avoided wherever practicable.

4. The poles, or towers, shall be located as far as practicable from inflammable material or structures.

5. The poles, or towers, supporting the crossing span, and the adjoining span on each side, preferably shall be in a straight line.

6. The wires, or cables, shall cross over telegraph, telephone and similar wires wherever practicable.

7. Cradles, or overhead bridges, shall not be used.

Clearance.

8. The side clearance shall be not less than 12 ft. from the nearest rail of main-line track, nor less than 6 ft. from the nearest rail of sidings. At loading sidings sufficient space shall be left for a driveway.

9. The clear headroom shall be not less than 30 ft. above the top of rail under the most unfavorable condition of temperature and loading. For constant potential, direct-current circuits, not exceeding 750 volts, when paralleled by trolley contact wires, the clear headroom need not exceed 25 ft.

10. The clearance of alternating-current circuits above any existing wires, under the most unfavorable condition of temperature and loading, shall be not less than 8 ft. wherever practicable. For constant potential, direct-current circuits, not exceeding 750 volts, the minimum clearance above telegraph, telephone and similar wires may be 2 ft. with insulated wires and 4 ft. with bare wires.

11. The separation of conductors carrying alternating current, supported by pin insulators, for spans not exceeding 150 ft., shall be not less than:

Line Voltage.	Separation.
Not exceeding 6,600 volts	14½ in.
Exceeding 6,600, but not exceeding 14,000	24 in.
Exceeding 14,000, but not exceeding 27,000	30 in.
Exceeding 27,000, but not exceeding 35,000	36 in.
Exceeding 35,000, but not exceeding 47,000	45 in.
Exceeding 47,000, but not exceeding 70,000	60 in.

For spans exceeding 150 ft. the pin spacing should be increased, depending upon the length of the span and the sag of the conductors.

Note.—This requirement does not apply to wires of the same phase or polarity between which there is no difference of potential.

With constant potential, direct-current circuits not exceeding 750 volts, the minimum spacing shall be 10 in.

12. When supported by insulators of the disc or suspension type, the crossing span and the next adjoining spans shall be dead-ended at the poles, or towers, supporting the crossing span, so that at these poles, or towers, the insulators shall be used as strain insulators.

13. The clearance in any direction between the conductors nearest the pole, or tower, and the pole or tower shall be not less than:

Line Voltage.	Clearance.
Not exceeding 10,000 volts	9 in.
Exceeding 10,000, but not exceeding 14,000	12 in.
Exceeding 14,000, but not exceeding 27,000	15 in.
Exceeding 27,000, but not exceeding 35,000	18 in.
Exceeding 35,000, but not exceeding 47,000	21 in.
Exceeding 47,000, but not exceeding 70,000	24 in.

Conductors.

14. The normal mechanical tension in the conductors generally shall be the same in the crossing span and in the adjoining span on each side, and the difference in length of the crossing and adjoining spans generally shall be not more than 50 per cent. of the length of the crossing span.

15. The conductors shall not be spliced in the crossing span nor in the adjoining span on either side.

16. The method of supporting the conductors at the poles, or towers, shall be such as to hold the wires, under maximum loading, to the supporting structures, in case of shattered insulators, or wires broken or burned at an insulator, without allowing an amount of slip which would materially reduce the clearance specified in paragraphs No. 9 and No. 10.

Guys.

17. Wooden poles supporting the crossing span shall be side-guyed in both directions, if practicable, and be head-guyed away from the crossing span. The next adjoining poles shall be head-guyed in both directions. Braces may be used instead of guys.

18. Strain insulators shall be used in guys from wooden poles carrying any power wire of less than 6,600 volts, provided the guys are not through grounded to permanently damp earth. Strain insulators shall not be used in guying steel structures, nor required on wooden poles carrying wires, all of which are 6,600 volts or more, provided the guys are through grounded to permanently damp earth.

Clearing.

19. The space around the poles, or towers, shall be kept free from inflammable material, underbrush and grass.

Signs.

20. In the case of railroad crossings, if required by the railroad company, warning signs of an approved design shall be placed on all poles and towers located on the railroad company's right-of-way.

Grounding.

21. For voltages over 5,000 volts, wooden crossarms, if used, shall be provided with a grounded metallic plate on top of the arm, which shall be not less than ⅛-in. in thickness and which shall have a sectional area and conductivity not less than that of the line conductor. Metal pins shall be electrically connected to this ground. Metal poles and metal arms on wooden poles shall be grounded.

22. The electrical conductivity of the ground conductor shall be adjusted to the short-circuit current capacity of the system and shall be not less than that of a No. 4 B. & S. gage copper wire.

Temperature.

23. In the computation of stresses and clearances, and in erection, provision shall be made for a variation in temperature from —20 degrees Fahrenheit to + 120 degrees Fahrenheit. A suitable modification in the temperature requirements shall be made for regions in which the above limits would not fairly represent the extreme range of temperature.

Inspection.

24. If required by contract, all material and workmanship shall be subject to the inspection of the company crossed; provided, that reasonable notice of the intention to make shop inspection shall be given by such company; if such notification is not given, the company crossed shall be furnished with certified reports of shop inspection of material and workmanship made by a properly qualified inspector. Defective material shall be rejected, and shall be removed and replaced with suitable material.

25. On the completion of the work, all false work, plant and rubbish, incident to the construction, shall be removed promptly and the site left unobstructed and clean.

Drawings.

26. If required, by contract, (   ) complete sets of general and detail drawings shall be furnished for approval, before any construction is commenced.

Loads.

27. The conductors shall be considered as uniformly loaded throughout their length with a load equal to the resultant of the dead load plus the weight of a layer of ice ½-in. in thickness, and a wind pressure of 8 lbs. per sq. ft, on the ice-covered diameter, at a temperature of 0 degrees Fahrenheit.

28. The weight of ice shall be assumed as 57 lbs. per cu. ft. (0.033 lb. per cu. in.).

29. Insulators, pins and conductor attachments shall be designed to withstand, with the designated factor of safety, the tension in the conductors under the maximum loading, assuming the conductor to be broken on one side of the structure.

30. The pole, or towers, shall be designed to withstand, with the designated factor of safety, the combined stresses from their own weight, the wind pressure on the pole, or tower, and the above wire loading on the crossing span and the next adjoining span on each side. The wind pressure on the poles, or towers, shall be assumed at 13 lbs. per sq. ft. on the projected area of solid or closed structures, and on 1½ times the projected area of latticed structures.

31. The poles, or towers, shall also be designed to withstand the most unfavorable condition of the loads specified in paragraph 30, combined with the unbalanced tension of two broken wires for poles, or towers, carrying 5 wires or less; three broken wires for poles, or towers, carrying 6 to 10 wires, and four broken wires for poles, or towers, carrying 11 or more wires.

32. Crossarms shall be designed to withstand the loading specified in paragraph 30, combined with the unbalanced

tension of the wire, which, when broken, produces the highest fiber stress in the arm.

33. The poles, or towers, may be permitted a reasonable deflection under the specified loading, provided that such deflection does not reduce the clearances specified in paragraph No. 10 more than 25 per cent. or produce stresses in excess of those specified in paragraphs Nos. 65 to 69.

Factors of Safety.

34. The ultimate unit stress divided by the allowable stress shall be not less than the following:

Wires and cables	2
Pins	2
Insulators, conductor attachments, guys	3
Wooden poles and crossarms	6
Structural steel	3
Reinforced concrete poles and crossarms	4
Foundations	2

Note.—The treating of wooden poles and crossarms is recommended. The treatment of wooden poles and crossarms should be by thorough impregnation with preservative by either closed or open-tank process. For poles, except in the case of yellow pine, the treatment need not extend higher than a point 2 ft. above the ground line.

minute, at an inclination of 45 deg. to the axis of the insulator.

The wet flash-over test shall be not less than:

Line Voltage.	Test Voltage.
Exceeding 9,000, but not exceeding 14,000..	40,000
Exceeding 14,000, but not exceeding 27,000..	60,000
Exceeding 27,000, but not exceeding 35,000..	80,000
Exceeding 35,000, but not exceeding 47,000..	100,000
Exceeding 47,000, but not exceeding 60,000..	120,000
Exceeding 60,000	twice the line voltage

39. Test voltages above 35,000 volts shall be determined by the A. I. E. E. standard spark-gap method.

40. Test voltages below 35,000 volts shall be determined by transformer ratio.

Material.

Conductors.

41. The conductors shall be of copper, aluminum, or other non-corrodible material, except that in exceptionally long spans, where the required mechanical strength cannot be obtained with the above materials, galvanized or copper-covered steel strand may be used.

42. For voltages not exceeding 750 volts, solid or stranded conductors may be used up to and including 4/0 in size;

Name of Company	Plan No.	Top or Under Contact	Protected	Uses Steam Equipment	Structures Clear Prop. Lines	Mileage in Operation	Mileage Planned for Immed. Future	Mileage Using Steam Equipment	Mileage Clearing Proposed Lines
Albany Southern	1	Top	No	Yes	Yes	65.00	....	65.00	65.00
Aurora, Elgin & Chicago	2	"	"	"	No	95.00	....	95.00	....
Baltimore & Ohio	3	"	Yes	"	Slight	8.70	....	8.70	8.70
Boston Elevated Ry	4	"	No	No	No	24.52	....	....	....
Brooklyn Rapid Transit	5	"	"	"	"	87.99	....	....	....
Northwestern Elevated, Chicago	6	"	"	"	"	60.00	....	....	....
Central California Traction	7	Under	Yes	Yes	Yes	45.00	....	45.00	45.00
Grand Rapids, Grand Haven & Muskegon	8	Top	No	No	No	41.26	....	....	....
Hudson & Manhattan	9	"	Yes	"	"	17.50	2.35	....	....
Interborough Rapid Transit	10, 11, 12	"	Partly	"	"	203.31	....	....	....
Lackawanna & Wyoming Valley	14	"	No	Yes	"	44.00	....	44.00	....
Long Island R. R.	13, 18	"	Yes	"	Yes	166.03	....	166.03	166.03
Metropolitan West Side, Chicago	6	"	No	No	No	49.64	....	....	....
Michigan United	16	"	"	Yes	"	107.00	....	107.00	....
Northern Electric Ry., Chico, Cal.	17	"	"	"	"	130.00	....	130.00	....
Penna. Tunnel & Terminal Co.	18	"	Yes	"	Yes	94.52	....	94.52	94.52
Puget Sound Electric Ry	19	"	No	"	No	37.50	....	37.50	....
Philadelphia & Western	20	Under	Yes	"	"	22.00	12.00	34.00	....
Scioto Valley Traction Co	21	Top	No	"	Yes	65.82	....	65.82	65.82
*Southern Pacific R. R.	......	......	......	....	....	......	......	......	......
South Side Elevated, Chicago	6	"	"	No	No	46.41	....	....	....
West Jersey & Sea Shore	23	"	Yes	Yes	Yes	143.00	....	143.00	143.00
Wilkesbarre & Hazelton	24	"	"	"	Slight	29.50	....	29.50	....
N. Y. C. & H. R. R. R.	26	Under	"	"	Yes	154.94	90.66	245.60	154.94
N. Y. C. & H. R. R. R., Utica to Syracuse	25	"	"	"	"	105.76	....	105.76	105.76
Detroit River Tunnel Co	26	"	"	"	"	19.27	....	19.27	19.27
Phila. Rapid Transit Co	....	"	"	No	No	18.61	....	....	....
Oneida Railway Co	25	"	"	Yes	Yes	105.76	....	96.23	105.76
Totals						1,988.04	105.01	1,531.93	973.80

*Single Catenary construction.

Data Regarding Third Rail Clearances, Revised Feb. 1, 1912.

Insulators.

35. Insulators for line voltages of less than 9,000 shall not flash over at four times the normal working voltage, under a precipitation of water of 1-5 of an in. per minute, at an inclination of 45 deg. to the axis of the insulator.

36. Each separate part of a built-up insulator, for line voltages over 9,000, shall be subjected to the dry flash-over test of that part for five consecutive minutes.

37. Each assembled and comented insulator shall be subjected to its dry flash-over test for five consecutive minutes.

The dry flash-over test shall be not less than:

Line Voltage.	Test Voltage.
Exceeding 9,000, but not exceeding 14,000..	65,000
Exceeding 14,000, but not exceeding 27,000..	100,000
Exceeding 27,000, but not exceeding 35,000..	125,000
Exceeding 35,000, but not exceeding 47,000..	150,000
Exceeding 47,000, but not exceeding 60,000..	180,000
Exceeding 60,000	3 times line voltage

Each insulator shall further be so designed that, with excessive potential, failure will first occur by flash-over and not by puncture.

38. Each assembled insulator shall be subjected to a wet flash-over test, under a precipitation of water of 1-5 in. per

above 4/0 in size, stranded conductors shall be used. For voltages exceeding 750 volts, and not exceeding 5,000 volts, solid or stranded conductors may be used up to and including 2/0 in size; above 2/0 in size, conductors shall be stranded. For voltages exceeding 5,000 volts, all conductors shall be stranded. Aluminum conductors for all voltages and sizes shall be stranded.

The minimum size of conductors shall be as follows:

No. 6 B. & S. gage copper for voltages not exceeding 5,000 volts.

No. 4 B. & S. gage copper for voltages exceeding 5,000 volts.

No. 1 B. & S. gage aluminum for all voltages.

Insulators.

43. Insulators shall be of porcelain for voltages exceeding 5,000 volts.

44. Strain insulators for guys shall have an ultimate strength of not less than twice that of the guy in which placed. Strain insulators shall be so constructed that the guy wires holding the insulator in position will interlock in case of the failure of the insulator.

Strain insulators for guys shall not flash over at four times the maximum line voltage, under a precipitation of water of 1/5 in. per minute, at an inclination of 45 deg. to the axis of the insulator.

Pins.

45. For voltages of 5,000 and over, insulator pins shall be steel, wrought iron, malleable iron, or other approved metal or alloy, and shall be galvanized, or otherwise protected from corrosion. Pins shall be locked with cotter, nut, or other device, to prevent raising out of the socket or hole in the cross-arm.

Guys.

46. Guys shall be galvanized or copper-covered stranded steel cable, not less than 5/16-in. in diameter, or galvanized rolled rods of equivalent tensile strength.

47. Guys to the ground shall connect to a galvanized anchor rod, extending at least one foot above the ground level.

48. The detail of the anchorage shall be definitely shown upon the plans.

and painting, and shall be free from pockets in which water or dirt can collect.

55. The length of a main compression member shall not exceed 150 times its least radius of gyration. The length of a secondary compression member shall not exceed 180 times its least radius of gyration.

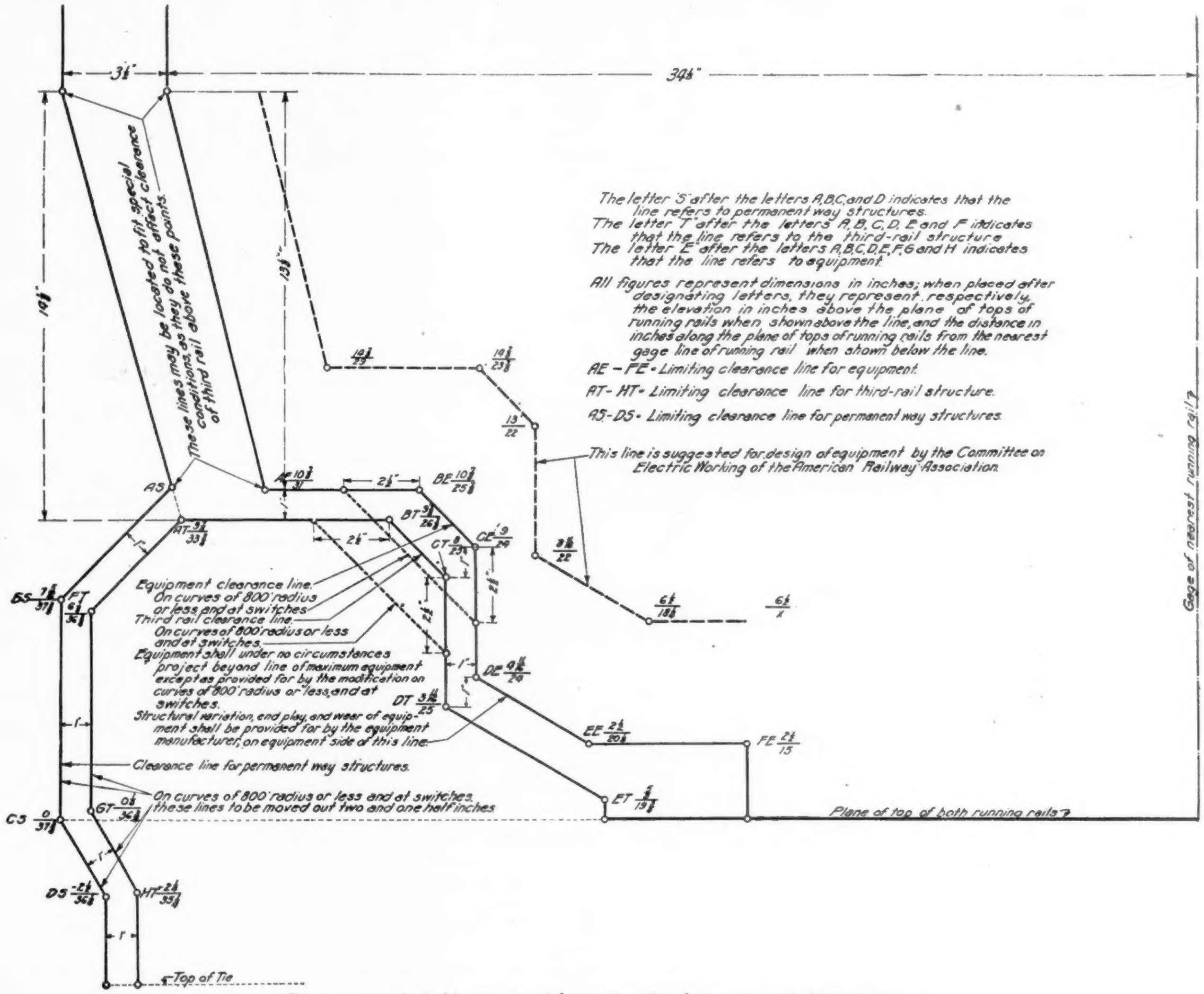
56. The minimum thickness of metal in galvanized structures shall be ¼-in. for main members, and ⅛-in. for secondary members. The minimum thickness of painted material shall be ¼-in.

Protective Coatings.

57. All structural steel shall be thoroughly cleaned at the shop and be galvanized, or given one coat of approved paint.

Painted Material.

58. All contact surfaces shall be given one coat of paint before assembling.



Recommended Clearance Lines for Equipment and Structures.

Wooden Poles.

49. Wooden poles shall be of selected timber of approved species, peeled, free from defects which would decrease their strength or durability, not less than 7 in. minimum diameter at the top, and meeting the requirements as specified in paragraphs 17, 30, 31 and 34.

Concrete.

50. All concrete and concrete material shall be in accordance with the requirements of the report of the joint committee on Concrete and Reinforced Concrete.

Structural Steel.

51. Structural steel shall be open-hearth, in accordance with the Manufacturers' Standard Specifications.

52. The design and workmanship shall be strictly in accordance with first-class practice.

53. The form of the frame shall be such that the stresses may be computed with reasonable accuracy, or the strength shall be determined by actual test.

54. The sections used shall permit inspection, cleaning

All painted structural steel shall be given two field coats of an approved paint.

The surface of the metal shall be thoroughly cleaned of all dirt, grease, scale, etc., before painting, and no painting shall be done in freezing or rainy weather.

Galvanized Material.

59. Galvanized material shall be in accordance with the specifications for galvanizing iron and steel.

Bolt holes in galvanized material shall be made before galvanizing.

Foundations.

60. The foundations for steel poles and towers shall be designed to prevent overturning.

The weight of concrete shall be assumed as 140 lbs. per cu. ft. In good ground, the weight of "earth" shall be assumed at 100 lbs. per cu. ft. In swampy ground, special measures shall be taken to prevent uplift or depression.

61. The top of the concrete foundation, or casing, shall

be not less than 12 in. above the surface of the ground or extreme high water.

62. When located in swampy ground, wooden crossing and next adjoining poles shall be set in barrels of broken stone or gravel, or in broken stone or timber footings.

63. When located in the sides of banks, or when subject to washouts, foundations shall be given additional depth, or be protected by cribbing or riprap.

64. All foundations and pole settings shall be tamped in 6-in. layers, while back filling.

Working Unit Stresses.

Obtained by dividing the ultimate breaking strength by the factors of safety given in paragraph 34.

Structural Steel.

		Lbs. per sq. in.
65.	Tension (net section)	18,000
	Shear	14,000
	Compression	$18{,}000 - 60\frac{l}{r}$

Rivets, Pins.

		Lbs. per sq. in.
66.	Shear	10,000
	Bearing	20,000
	Bending	20,000

Bolts.

67.	Shear	8,500
	Bearing	17,000
	Bending	17,000

Wires and Cables.

		Lbs. per sq. in.
68.	Copper, hard-drawn, solid, B. & S. gage, 4/0, 3/0, 2/0	25,000
	Copper, hard-drawn, solid, B. & S. gage, 1/0	27,500
	Copper, hard-drawn, solid, B. & S. gage, No. 1	28,500
	Copper, hard-drawn, solid, B. & S. gage, No. 2, 4, 6	30,000
	Copper, soft-drawn, solid, B. & S.	17,000
	Copper, hard-drawn, stranded, B. & S.	30,000
	Copper, soft-drawn, stranded, B. & S.	17,000
	Aluminum, hard-drawn, stranded, B. & S. gage under 4/0	12,000
	Aluminum, hard-drawn, stranded, B. & S. gage 4/0 and over	11,500

Untreated Timber.

		Bending.	Compression.
69.	Eastern white cedar.	600 lbs. per sq. in.	$600\left(1-\frac{L}{60\,D}\right)$
	Chestnut	850 lbs. per sq. in.	850 "
	Washington cedar	850 lbs. per sq. in.	850 "
	Idaho cedar	850 lbs. per sq. in.	850 "
	Port Orford cedar	1150 lbs. per sq. in.	1150 "
	Long-leaf yellow pine	1100 lbs. per sq. in.	1100 "
	Short-leaf yellow pine	950 lbs. per sq. in.	950 "
	Douglas fir	1000 lbs. per sq. in.	1000 "
	White oak	950 lbs. per sq. in.	950 "
	Red cedar	700 lbs. per sq. in.	700 "
	Bald cypress (heart-wood)	800 lbs. per sq. in.	800 "
	Redwood	850 lbs. per sq. in.	850 "
	Catalpa	500 lbs. per sq. in.	500 "
	Juniper	550 lbs. per sq. in.	550 "

L = Length in inches.
D = Least side, or diameter, in inches.

SPECIFICATIONS FOR GALVANIZING FOR IRON OR STEEL.

These specifications give in detail the test to be applied to galvanized material. All specimens shall be capable of withstanding these tests.

Coating.

(A) The galvanizing shall consist of a continuous coating of pure zinc of uniform thickness, and so applied that it adheres firmly to the surface of the iron or steel. The finished product shall be smooth.

Cleaning.

(B) The samples shall be cleaned before testing, first with carbona, benzine or turpentine and cotton waste (not with a brush), and then thoroughly rinsed in clean water and wiped dry with clean cotton waste.

The sample shall be clean and dry before each immersion in the solution.

Solution.

(C) The standard solution of copper sulphate shall consist of commercial copper sulphate crystals dissolved in cold water, about in the proportion of 36 parts, by weight, of crystals to 100 parts, by weight, of water. The solution shall be neutralized by the addition of an excess of chemically pure cupric oxide (Cu O). The presence of an excess of cupric oxide will be shown by the sediment of this reagent at the bottom of the containing vessel.

The neutralized solution shall be filtered before using by passing through filter paper. The filtered solution shall have a specific gravity of 1.186 at 65 deg. Fahrenheit (reading the scale at the level of the solution) at the beginning of each test. In case the filtered solution is high in specific gravity, clean water shall be added to reduce the specific gravity at 1.186 at 65 deg. Fahrenheit. In case the filtered solution is low in specific gravity, filtered solution of a higher specific gravity shall be added to make the specific gravity 1.186 at 65 deg. Fahrenheit.

As soon as the stronger solution is taken from the vessel containing the unfiltered neutralized stock solution, additional crystals and water must be added to the stock solution. An excess of cupric oxide shall always be kept in the unfiltered stock solution.

Quantity of Solution.

(D) Wire samples shall be tested in a glass jar of at least 2 in. inside diameter. The jar without the wire samples shall be filled with standard solution to a depth of at least 4 in. Hardware samples shall be tested in a glass or earthenware jar containing at least ½ pint of standard solution for each hardware sample.

Solution shall not be used for more than one series of four immersions.

Samples.

(E) Not more than seven wires shall be simultaneously immersed, and not more than one sample of galvanized material other than wire shall be immersed in the specified quantity of solution.

The samples shall not be grouped or twisted together, but shall be well separated so as to permit the action of the solution to be uniform upon all immersed portions of the samples.

Test.

(F) Clean and dry samples shall be immersed in the required quantity of standard solution in accordance with the following cycle of immersions.

The temperature of the solution shall be maintained between 62 deg. and 68 deg. Fahrenheit at all times during the following test:

(1) Immerse for one minute, wash and wipe dry.
(2) Immerse for one minute, wash and wipe dry.
(3) Immerse for one minute, wash and wipe dry.
(4) Immerse for one minute, wash and wipe dry.

After each immersion the samples shall be immediately washed in clean water having a temperature between 62 deg. and 68 deg. Fahrenheit, and wiped dry with cotton waste.

In the case of No. 14 galvanized iron or steel wire, the time of the fourth immersion shall be reduced to ½ minute.

Rejection.

(G) If after the test described in section (F) there should be a bright metallic copper deposit upon the samples, the lot represented by the sample shall be rejected.

Copper deposits on zinc or within 1 in. of the cut end shall not be considered causes for rejection.

In the case of a failure of only one wire in a group of seven wires immersed together, or if there is a reasonable doubt as to the copper deposit, two check tests shall be made on these seven wires and the lot reported in accordance with the majority of the sets of tests.

Note.—The equipment necessary for the tests herein outlined is as follows:

Filter paper.
Commercial copper sulphate crystals.
Chemically pure cupric oxide (Cu O).
Running water.
Warm water or ice, as per needs.
Carbona, benzine or turpentine.
Glass jars at least 2 in. inside diameter by at least 4½ in. high.
Glass or earthenware jars for hardware samples.
Vessel for washing samples.
Tray for holding jars of stock solution.
Jars, bottles and porcelain basket for stock solution.
Cotton waste.
Hydrometer cylinder 3 in. diameter by 15 in. high.
Thermometer with large Fahrenheit scale correct at 62 and 68 deg.
Hydrometer correct at 1.186 at 65 deg. Fahrenheit.

APPENDIX B.

Paragraphs in Specifications for Overhead Crossing of Electric Light and Power Lines as Adopted by Other Associations.

10. The clearance of alternating-current circuits above any existing wires, under the most unfavorable condition of temperature and loading, shall be not less than 8 ft. wherever possible. For constant potential, direct-current circuits, not exceeding 750 volts, the minimum clearance above telegraph, telephone and similar wires may be 2 ft. with insulated wires and 4 ft. with bare wires.

13. The clearance in any direction between the conductors nearest the pole, or tower, and the pole, or tower, shall be not less than:

Line Voltage.	Clearances.
Not exceeding 14,000 volts	9 in.
Exceeding 14,000 but not exceeding 27,000	15 in.
Exceeding 27,000 but not exceeding 35,000	18 in.
Exceeding 35,000 but not exceeding 47,000	21 in.
Exceeding 47,000 but not exceeding 70,000	24 in.

18. Strain insulators shall be used in guys from wooden poles carrying any power wire of less than 6,600 volts. Strain insulators shall not be used in guying steel structures, nor required on wooden poles carrying wires all of which are 6,600 volts or more.

Inspection.

24. If required by contract, all material and workmanship shall be subject to the inspection of the company crossed; provided that reasonable notice of the intention to make shop inspection shall be given by such company. Defective material shall be rejected, and shall be removed and replaced with suitable material.

29. Insulators, pins and conductor attachments shall be designed to withstand, with the designated factor of safety, the tension in the conductors under the maximum loading.

31. The poles, or towers, shall also be designed to withstand the loads specified in paragraph No. 30, combined with the unbalanced tension of: Two broken wires for poles, or towers, carrying 5 wires or less; three broken wires for poles, or towers, carrying 6 to 10 wires; and four broken wires for poles, or towers, carrying 11 or more wires.

32. Crossarms shall be designed to withstand the loading specified in paragraph No. 30, combined with the unbalanced tension of one wire broken at the pin farthest from the pole.

34. The ultimate unit stress divided by the allowable unit stress shall be not less than the following:

Wires and cables	2
Pins	2
Insulator, conductor attachments, guys	3
Wooden poles and crossarms	6
Structural steel	3
Reinforced concrete poles and crossarms	4
Foundations	2

Note.—The use of treated wooden poles and crossarms is recommended. The treatment of wooden poles and crossarms should be by thorough impregnation with preservative by either closed or open-tank process. For poles, except in the case of yellow pine, the treatment need not extend higher than a point 2 ft. above the ground line.

Pins.

45. For voltages of 5,000 and over, insulator pins shall be of steel, wrought iron, malleable iron, or other approved metal or alloy, and shall be galvanized, or otherwise protected from corrosion.

Wooden Poles.

49. Wooden poles shall be of selected timber, peeled, free from defects which would decrease their strength or durability, not less than 7 in. minimum diameter at the top, and meeting the requirements as specified in paragraphs 17, 30, 31 and 34.

51. Structural steel shall be in accordance with the Manufacturers' Standard Specifications.

55. The length of a main compression member shall not exceed 180 times its least radius of gyration. The length of a secondary compression member shall not exceed 220 times its least radius of gyration.

60. The foundations for steel poles and towers shall be designed to prevent overturning.

The weight of concrete shall be assumed as 140 lbs. per cu. ft. In good ground, the weight of "earth" (calculated at 30 deg. from the vertical) shall be assumed as 100 lbs. per cu. ft. In swampy ground, special measures shall be taken to prevent uplift or depression.

61. The top of the concrete foundation, or casing, shall be not less than 6 in. above the surface of the ground, nor less than 1 ft. above extreme high water.

Discussion on Electricity.

Mr. Kittredge: I want to say a word or two in regard to the specifications for Overhead Crossings of Electric Light and Power Lines. Within the last four months committees of the National Electric Light Association, the American Institute of Electrical Engineers, the American Electric Railway Association and the Association of Railway Telegraph Superintendents made a joint report, which corresponds very closely to the report of this committee. The differences are in paragraphs 10, 13, 18, 24, 29, 31, 32, 34, 45, 49, 51, 55, 60 and 61. In some of these paragraphs the changes are simply those of words. In one case I recall the word "practicable" is used for the word "possible," and in another place where it says "Treated poles are recommended," it really means where wooden poles are to be used, that they shall be treated. It does not mean that we recommend the use of wooden poles, but if they are used they shall be treated. In some cases the phraseology in our report has been changed for the better, we think, and this applies to the majority of the differences. There are a few items, which if the various paragraphs come up for discussion, can be enlarged on.

It seems to be a very great advantage to have a report upon these crossings which will be accepted and acknowledged by the principal companies interested in such construction. In New York, we can control the crossings over our right of way, but we have very little to say about crossings which occur in highways. The crossing companies have rights which apparently are co-extensive with those of the railways and almost any old thing does for a crossing in a highway. It is, of course, very desirable in the first place that we get safe construction, and in the second place good construction at the highways as well as at private crossings.

We are led to believe by members of the Joint Committee that if we will accept their report, using their phraseology, we will be in a very much better condition than if we do not, as some of the members of the Joint Committee were brought into line only after a great deal of hard work. They take the position that if this association does not accept specifications which are the same as theirs it will negative their whole work and let things stand as they are at the present time.

The President: We will take up the specifications by paragraphs.

G. A. Mountain (Can. Ry. Com.): I see trolley contacts are excepted in clause 9; with reference to the clearance of 25 feet. Has the committee any recommendation to make on that?

Mr. Kittridge: We have no recommendation.

Mr. Kittridge: The only difference in paragraph 10 is the word "practicable" in the third line. The joint report uses the word "possible."

Mr. Kittridge: I move, for the purpose of getting a contract which is similar in all respects, that we adopt the word "possible" instead of the word "practicable." Motion carried.

Mr. Pfeifer: I notice that the maximum line voltage in paragrhph 11 is put at 7,000 volts. The Terminal Railroad Association now has an application for a line crossing with 10,000 volts. I would like to know what provision could be made for that.

J. R. W. Ambrose (G. T.): I was going to bring up the same point. We have several crossings to-day of 110,000 volts.

The President: That seems to be a subject for further consideration on the part of the committee.

Mr. Kittridge: Section 13 varies from the report of the Joint Committee, in that our report contains one more division. The joint report says for not exceeding 14,000 volts, clearance, 9 in. We have for not exceeding 10,000 volts, clearance, 9 in., exceeding 10,000 but not exceeding 14,000 clearance, 12 in. I recommend the adoption of this paragraph, as shown.

Motion carried.

Mr. Kittredge: Section 18 varies from the paragraph of the Joint Committee in that beginning on the second line we have inserted the words, "Provided the guys are not through grounded to permanently damp earth," and at the end of the paragraph we have added the words "provided the guys are through grounded to permanently damp earth."

This paragraph is important and we believe the revisions we have made are so important that we could not change this

paragraph. In a conference with Mr. Osgood, the chairman of the Joint Committee, he told me, he would undertake to have his association adopt No. 18 as written by us provided we would adopt the others as written by him. I move the adoption of paragraph 18 as written. Motion carried.

Mr. Coombs: The following letter from Mr. Osgood of the Joint Committee was written before the action of the committee to-day was known.

The specification, as written, has been formally ratified and adopted by the National Electric Light Association, the American Institute of Electrical Engineers, the Association of Railway Telegraph Superintendents and the Engineering and Standards Committee of the American Electric Railway Engineering Association (the matter now being up for letter ballot by that association, requiring under their rules a delay of one year), the American Telephone and Telegraph Company, the Western Union Telegraph Company, and the Postal Telegraph-Cable Company.

A study of the changes recommended brings out the rather remarkable fact that alterations are recommended in only thirteen paragraphs out of a specification of some twenty-eight printed pages, and the joint committee which formulated this specification honestly believes that the differences are so slight that they are of no great engineering importance.

The list of names of the joint committee shows that the men are of very wide experience in the field of work under discussion, and are representative of all conflicting interests in overhead construction work, and the fact that so many engineers have agreed upon a specification, and the fact that the associations and large companies represented by these men have approved the specification, is a very strong indication that the specification must be a good one and sufficiently safe for our mutual purposes, and it is such a great improvement over anything which has ever before been offered, that we feel it our real duty to ask you to reconsider this matter in the broadest possible way.

Mr. Kittredge: In paragraph 24 it says: "If such notification is not given, the company crossed shall be furnished with certified reports of shop inspection of material and workmanship made by a properly qualified inspector." These words do not appear in the report of the Joint Committee, and I move the adoption of paragraph 24 of the Joint Committee report.

Motion carried.

A. F. Robinson (A. T. & S. F.): It seems to me that that provision for load in paragraph 27 is hardly sufficient. When ice gathers on wires it seldom forms in a circle. It is oblong and hangs to one side of the wire. That would vitiate the use of a wind pressure of 8 lbs. per sq. ft., because it is striking more nearly on a plane surface than it would if blowing against the cylinder. It also seems to me it would be better if we could arrive at a uniform load per lineal foot, without respect to the size of the wire or size of the supporting cable. It is a matter of very small moment when you work it out. If you take a 1½-in. wire, it means about 1.4 lbs. per lineal foot, and it seems to me we could cut nearly all of that out and put in a provision that the wires shall be figured for 10, 15 or 20 lbs. per lineal foot, and not say anything about the ice. I would offer that as a suggestion, for the consideration of the committee in future revisions of the specification.

Mr. Kittredge: Paragraph 29 also differs from the Joint Committee report and I move the adoption of paragraph 29 of the Joint Committee Report.

Motion carried.

Mr. Kittredge: Paragraph 31 contains the words "The most unfavorable condition," which the paragraph of the Joint Committee does not contain. I move the adoption of paragraph 31 of the Joint Committee.

E. B. Katte (N. Y. C. & H. R.): At the largest meeting the Committee on Electricity ever had we agreed to suggest these modifications. I believe it has been generally accepted by nearly all of the committees, that the modifications are good. I have been told that the Joint Committee would consider these modifications and in all probability would adopt some, if not all of them at their next meeting, six months from now. During the six months following that meeting we will be behind. Our specifications will contain 13 clauses that are, perhaps, ambiguous. If we adopt to-day the specifications as modified, we will be six months in advance of the other specifications and in advance of the other committee. Next fall they will perhaps adopt the specifications that you adopt to-day; then we will have standard specifications six months in advance of the time that we should have them if we don't adopt the specifications as recommended to-day.

Mr. Coombs: The main argument for warning this association not to make changes is to obtain a uniform national standard, and the engineering differences are so slight that personally I do not believe that any construction will be impaired during that six months.

Mr. Katte: The association has already adopted one change in clause 18. The specifications will not be uniform. As long as you have made one change, why not make all the other changes?

Mr. Fritch: If we were independent and could say, "We will adopt our own specifications," the chances are the other associations would throw them out, and at about 90 per cent of the crossings we would have to take whatever they would give us, and, for the sake of uniformity, believe we ought to adopt these specifications, with the exception of clause 18.

The motion to adopt paragraph 31 was carried.

Paragraphs 32, 34, 45, 49, 51, 55, 60 and 61, in which the Joint Committee report differed from the report of the Electricity Committee, were adopted in the form presented by the Joint Committee.

THE ANNUAL DINNER.

The annual dinner of the American Railway Engineering Association was given in the Gold room of the Congress hotel last night. President W. C. Cushing acted as toastmaster, and the addresses were by L. F. Loree, president of the Delaware & Hudson; Hon. F. D. Monk, K. C., M. P., Minister of Public Works of Canada and Ray Morris, of White, Weld & Company, a new York firm of bankers. Mr. Loree was unable to be present, and his address was read by George H. Burgess, chief engineer of the Delaware & Hudson. Almost 400 persons attended the dinner.

After the three addresses, President Cushing expressed the appreciation of the association of the exhibit at the Coliseum, and President Belknap of the Appliance Association thanked the members of the Engineering Association for their interest and attendance.

In beginning the speakers' program President Cushing said:

"Fellow members and guests of the American Railway Engineering Association, the following anecdote is called 'After the Refreshments.' 'Ah say, Miss Mandy, am yo' program full?' 'Lordee, no, Mr. Lumley, it takes mo' an san'wich an' two olives to fill mah program.'

"As I hope you have all finished the task of filling your program, I ask you to begin this evening of enjoyment with a toast to the health of His Excellency, the President of the United States. (A toast was then drunk, with the accompaniment of "Star Spangled Banner" by the orchestra.) Gentlemen, I now offer you a toast to the health of his Royal Highness, the Governor General of the Dominion of Canada. (The toast was accompanied by music, "God Save the King.") Gentlemen, 'The world was sad, the garden was a wild, and man, the hermit, sighed, still woman smiled.' I ask you to drink to her health, beauty, sweetness and nobility." (A toast was accordingly tendered, accompanied by music, "Annie Laurie.") Mr. Cushing then announced the result of the election of officers, which is given on another page. "With those names," said Mr. Cushing, "you can be assured of the continuous success of the association."

The following were the addresses:

Mr. Loree on Labor Unionism.

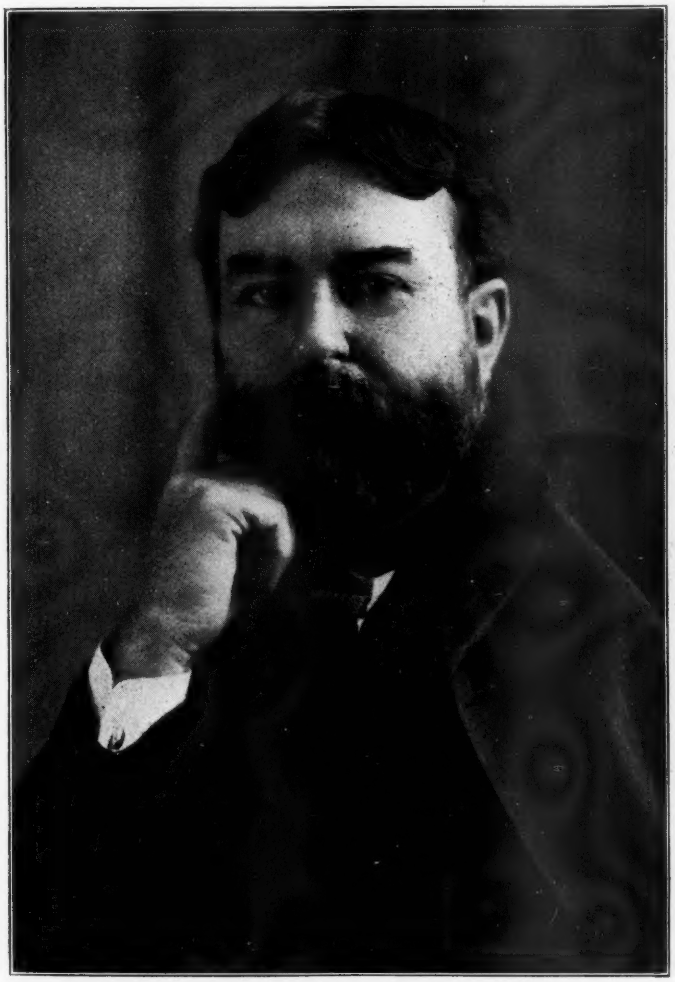
We boast ourselves in season and out of season upon our freedom of speech. As a matter of fact, we let things go to the devil without saying a word, because, as a people, we conceive a personal dislike for anyone who expresses a difference of opinion. Warned by this characteristic, and coming at the invitation of your president to talk to you about labor unions, I pray you to hear me with an open mind and to judge me for my purpose.

It has been said that books are too often written out of other books and too seldom out of the life of man, but notwithstanding that criticism, in view of the largeness of the subject and the limitations of our time, I have done no more

than to go through the literature, especially the work of the Webbs and the publications of the Johns Hopkins University, to give you from it as clear a picture as I am able to draw.

When the Roman Empire had fallen, society began slowly to evolve for its preservation a government of a feudal structure. This was in its essence an enlargement of the patriarchal type, the feudal chief charging himself with the care of his retainers. As this system slowly crumbled, and as industry developed, there arose craft guilds, formed among the men suffering from this disorganization, in order that they might retain independence and order.

The final disintegration of the feudal system and the rapid development of industry destroyed the guilds, and the dominant industrial policy of the sixteenth century was the establishment of some regulating authority to perform, for the trade of the time, the services formerly rendered by the craft guild, and more and more this fell into the hands of the government. The statesmen of Queen Elizabeth's time had enacted a statute of apprentices, through which they contrived arrangements which would, as they hoped, "yield unto the hired persons, both in time of scarcity and in time of plenty, a convenient proportion of wages," and it was the non-enforcement of this statute that gave rise to the trades unions, whose common purpose then was the enforcement of the law on the subject, and appeals to the government to save the wage-earners from the new policy of buying labor, like raw material in manufacture, in the cheapest market.



L. F. LOREE.

F. D. MONK.

It is often assumed that trades unions arose as the descendant of the craft guild. There is, in fact, no connection, direct or indirect, between the ancient and modern forms of trade combination. The two organizations are entirely different, both in structure and function. The central figure of the guild organization, in all instances, and at all periods of its development, was the master craftsman, owning the instruments of production and selling the product. He supplied whatever capital was needed in his industry, and that knowledge of the markets for both raw material and product which is the special function of the entrepreneur.

Neither is it true that trade unionism arose as a protest against intolerable industrial oppression, nor that it is a product of the steam engine and the factory system. For whilst industrial oppression belongs to all ages, it is not until the changing conditions of industry had materially reduced the chance of each journeyman becoming himself a master that ephemeral combinations passed into permanent trade societies, recruited for many years from trades carried on exclusively by hand-workers, for the unions had preceded the factory system by half a century.

The modern labor organization rests on the definite separation between the functions of the capitalist and the workman; or, in other words, between the direction of industrial operations and their execution in detail, between the property owner and the brain-worker on the one hand and the manual-workers on the other. The trade union is "a continuous association of wage-earners for the purpose of maintaining or improving the condition of their employment."

The pioneers of the trade union movement were the extensive combinations of the west of England woolen-workers and the Midland frame-work knitters. There would appear to be no evidence of the existence prior to 1700 of continuous association of wage-earners. Throughout the eighteenth century they had a meager and uncertain existence, but the introduction of the factory system was accompanied by a rapid rise in trade combinations, and early in the nineteenth century they would seem to have become very highly developed and firmly established in many trades. The struggle for existence went on until 1825, and they languished through a long period of commercial depression until, with the business revival of 1843, they began to acquire a financial strength and a permanence of membership hitherto unknown, through a combination of the functions of a trade protective society with those of a permanent insurance company, while the leadership shifted from the casual enthusiast and agitator to a class of permanent, salaried officers, which new model had become generally adopted by 1860. Then came a new idea; the use of the combined trade union organization for legislative agitation, the demand that the government take up again its theories of the sixteenth century and regulate in detail conditions of labor; and now, since 1889, we find the whole trade union world permeated with collective ideas and drifting toward Socialism.

It would seem impossible, by a statistical survey, to give

an adequate idea of the trade union organization. It numbers in the United States apparently about 2 per cent of the population and about 10 per cent of those engaged in gainful occupations. What gives it great significance is the massing of trade unionists in certain industries and districts, where the population is comparatively dense and where industry is conducted on a large scale, in such a way as to form a powerful element of the industrial world. Perhaps three-fourths of its members are engaged in building, in mining, in steam and electric transportation, and in the machinists' trades. In certain districts and in certain industries, membership is practically co-extensive with the manual laborers. On the other hand, there are many occupations in which trade unionism is non-existent. In its growth, speaking generally, the strong have become stronger, whilst those that were weak are now even weaker than they were.

The trade union world has, throughout its whole history, manifested an overpowering impulse to the amalgamation of local trade clubs into national unions, with centralized funds and centralized administration. This centralization of administration, involving the adoption of a national trade policy, and above all the constant leveling up of the lower-paid districts to the higher standards set in more advantageous centers, requires, it is clear, the development of a salaried staff, selected for special capacity, devoting their whole attention to the commercial position and technical details of the particular section of the industry that they represent, and able to act for the whole of that section throughout the nation. Besides the active members of the trade union ranks, numbering perhaps 2,000,000, there is a smaller class of non-commissioned officers made up of the secretaries and presidents of local unions, branches and district committees of national societies, and of trades councils. These men number 20,000 or more; they form the skeleton of the trade union world and constitute the vital element in its politics. The actual government rests exclusively in the hands of a class apart, the salaried officers of the great societies, numbering at the present time scarcely more than 600, and these in turn are dominated by an inner circle of a few score. Looking at this development and the present situation, it is an interesting question as to whether we now have a condition of organized labor or a condition of labor professionally organized; whether this great mass is energized from below and consciously seeks its betterment, or whether it responds to pressure from above and is being exploited for the benefit of its rulers.

RAY MORRIS.

Notwithstanding their almost infinite variety of technical detail, the activities of trade unionism may be reduced to two economic devices—restriction of numbers and the common rule. To the former type belong the entrance to a trade, the right to a trade, continuity of employment, and new processes and machinery. The latter type includes the more modern rules directly fixing a standard rate, a normal day, and definite conditions of sanitation and safety.

The early efforts of the unions looked to the creation of an artificial scarcity of labor. They sought to restrict the entrance to a trade by the establishment of a long period of apprenticeship; to restrict the right to an apprenticeship to a patrimony to be conferred by the father upon his sons, and to restrict the number of apprentices to one for four or five journeymen; to enforce a limitation of boy labor and of handy-men, and to limit the progression of the latter within the trade; to totally exclude women therefrom; while some, by imposing large initiation fees or other penalties, tried to keep out many possible aspirants. Each union sought to secure for its members the whole of the work which it considered belonged to it according to usage and custom, and to secure for them continuity of employment, while all considered improvements which tended to lessen the demand for human labor as the deadliest curse which could possibly fall on the heads of the working classes.

The later efforts of the unions enlarge this program by the creation of an artificial demand for labor. They seek payment according to some definite standard, uniform in its application, covering equally payment by the piece and payment by time, with guaranteed minimum wage; a uniform maximum working time for all members of the craft as fixing a definite unit of measure, and a constant reduction of working hours as a means of making work to absorb surplus labor; a demand for safe, healthy and comfortable

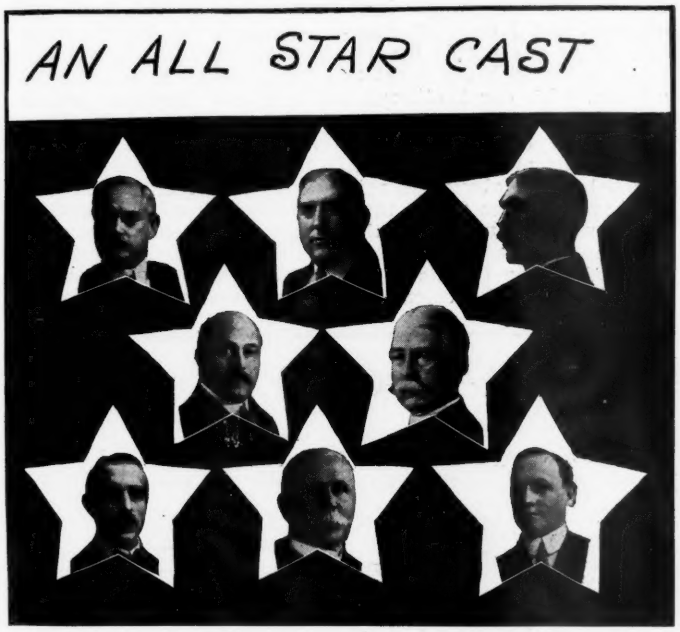
conditions of work, compensation for accidents, whether avoidable or unavoidable, and permanent support when out of work, or invalided, and during old age.

If now, we ask how this extensive body, with this ambitious program, is held together, we are able to identify the following forces:

(1) The trade union organization is, as a unit, a lodge with a ritual largely based upon that of the Odd Fellows, and supplies to men with a common experience and who are brought frequently into personal contact, much social attraction, and, to the active and ambitious, opportunity for personal prominence and the exercise of individual power.

(2) The cohesion, the permanence of membership, the continuity of existence, rest upon the method of mutual insurance. But probably by far the most potent force is the pressure brought by the dominant spirits upon the isolated and unprotected individual. Whether this takes the form of the temporary abstraction of the tools of a workman; interference with his work; personal annoyance; the abuse or an ostracism of his family, or other of the manifold ways in which this pressure is exerted,—they are all infringements of personal liberty and an assertion of the right and the intention to make trade unionism compulsory. In their ultimate development, these coercive measures create the closed shop, with its concommitant devices of membership cards and buttons, the "check-off" system, and the union label.

(3) By their opposition to home work, small masters' separate arrangements with particular employers, profit-sharing, pension funds, employes' benefit societies, and similar efforts to bring about mutuality of interest, trade unions are instinctively biased and consistently work to bring about a horizontal cleavage of society. Anyone enmeshed in their particular strata would then find escape impossible; all the worse features of the caste system would be invoked, and the chief merit of democracy, which is the open passage from the lowest to the highest position in the community, would be defeated.



If, further, we look to ascertain the methods by which trade unionism seeks to enforce its claims upon the employer, we find from the beginning of the eighteenth century down to the present day, the continuous employment of the method of legal enactment, whilst only intermittently during the eighteenth century, and not openly and avowedly until 1824, could they rely on the method of collective bargaining.

The method of legal enactment results in the labor unions maintaining at every session of the state legislatures and of Congress a lobby working in their interest. The control of the law is invoked for sanitation and safety, for limitation of the hours of labor, for restriction of labor of women and children and of the age at which youth may be employed, for the creation of parasitic labor, and in many other ways that constitute a great burden upon the community. It has destroyed many efforts that might have been developed to ameliorate conditions. For example, the "company stores" insured the woman the right to use enough of her husband's wages to provide for the full nourishment of the family, and prevented their dissipation in drink or other debauchery. All the arguments that can be urged in favor of the mechanics' lien could be marshalled in support of this institution. Its abuses should have been weeded out and the institution itself carefully conserved, with the incorporation of the profit-sharing principle. This legislation has made the struggle for existence harder for the farmer and the small manufacturer in the country town, and if in the short view it has helped those in whose interest it was passed, which is doubtful, it has in the main been hurtful to the rest of the community.

The method of collective bargaining, which is the form in which these activities are most familiar, has never commended itself to the employer, and where the two parties are more nearly equal in strength, has, after trial, generally been abandoned. The chief difficulties seem to be the lack of responsibility on the part of the labor unions in observing the bargain when made, and the disposition of the unions to assert under their rules the authority to control the shop and the methods used.

As to the strike, with its concomitants, the boycott and other militant methods, upon which the strength of the union appears ultimately to depend, it constitutes industrial war and has all the defects of war. The strike always reveals the use of means that could only be resorted to by those familiar with the technique of the trade. Its effectiveness would appear to depend upon disorder, violence and crime, which have distinguished it in all countries, at all times, and among all unions. The unions have never undertaken to discipline or expel members known to have resorted to violence, nor have they in any way assisted the authorities in preventing such action or in punishing it when committed; and their uniform denunciation of the courts with their injunctions, the navy, the army and the militia, the sheriff with his posse comitatus, the police, and even the boy scouts, indicates a systematic effort to weaken all the resources that civilization has developed for the preservation of order.

Finally, if we seek for the grounds upon which the trades unions base their claim for an existence, there would appear to be two contentions, not necessarily related:

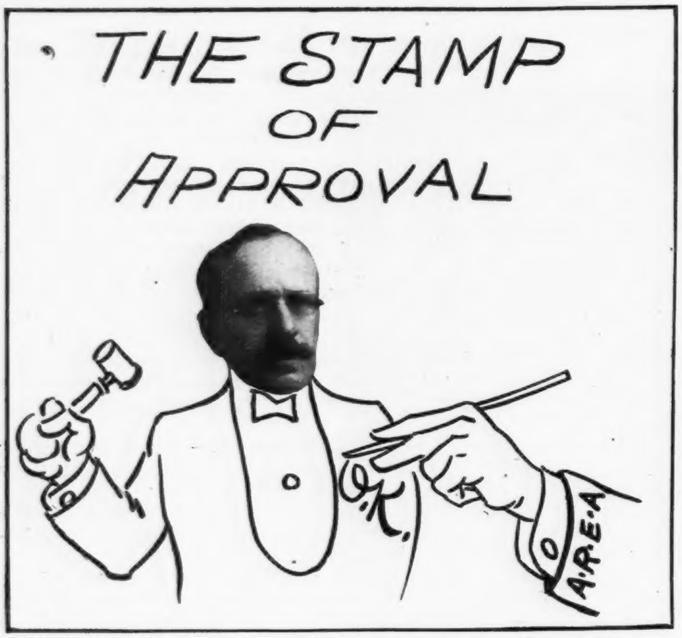
That the actual producers do not obtain their share of the wealth they create; and that the laborer is entitled to a living wage.

No one thing, perhaps, so embitters as a sense of injustice, and I am satisfied that much of the resentment of the workman is due to his belief in the assurances that have been made him by his leaders that he was not getting his fair share of the joint product, and it is highly important that the facts with regard to this be determined and be widely diffused. I am not aware of any considerable body of information regarding the relative contributions to value by the property owners, the brain-workers and the manual-workers. It would seem desirable to undertake a physical valuation of labor. Were this done it would probably be found that in most industries the wages of labor are already substantially in excess of the contribution made by labor to the value of the product. It is a realization of this that is at the bottom of the contention of the Socialists that the instruments of production should be the property of the state.

The continued efficiency of the nation's industry obviously depends on the continuance of its citizens in health and strength, and the maintenance of its workers, unimpaired in numbers and vigor, with a sufficient number of children to fill the vacancies caused by death or superannuation. But to arrange for this through a living wage is not so simple as to state it. A serious difficulty is our lack of precise knowledge as to what are the conditions of healthy life and industrial efficiency. There are practically no scientific data from which we can compute the needs of particular occupations. The customary standards of life differ from class to class to such an extent as to bear no discoverable relation to the waste and repair involved in the respective social functions of the various grades. Even if we could come to some conclusion as to the "normal ration" required to keep each trade in health, we would still be unable to decide how much must be added in each case to compensate for irregularity of employment. If special wages were fixed to meet the special needs of particular trades, neither the employer nor the community would have any guarantee that the extra sum allowed would be spent in extra nourishment, proper recreation, or insurance against periods of unemployment. With regard to the proper limits to be set to the duration of toil, while all would welcome a maximum working day consistent with the healthy existence, home life and citizenship of the average workmen, yet in the final analysis the whole destiny of man must rest upon the use made of his leisure time. It is a sinister experience that a holiday will fill the hospitals with victims whom months of toil have left unscathed.

What is distrusted in trade unionism is not its object nor even its devices, but its structure and its methods; the self-

perpetuating governing oligarchy, the creation of parasitic labor, the laying idle of costly and perishable machinery in plant, the dislocation of business enterprises, the diversion of orders to other communities and other countries, and the absorption in angry quarrels of intellects which would otherwise be devoted to the further development of industry; above all, the reduction to poverty and semi-starvation of thousands of workmen, involve a serious inroad upon the nation's wealth. The right to work is the property of every man, and this property, if Saint Paul was right when he said that "He who does not provide for his own is worse than a heathen," is the first, the most sacred, and the most inalienable of all. If trade unionism is to rest upon collective bargaining, and if this implies in its fullest development compulsory membership, then it menaces the fundamental rights of citizenship. The justification put forward for this compulsion is that it is for the good of the compelled. It is not reassuring to recall that this was the basis for the religious persecutions of the past, and it is significant that the trade unions display the same intolerance, the same extreme claims for superior rights, and the same ferocious cruelty, that characterized the persecuting sects.



It is difficult to understand why, under this constant and great pressure, the employers were not early driven into combinations for purposes of resistance or aggression. In 1902 and 1903 there were formed in numerous cities organizations called "Citizens' Alliances," of which Los Angeles has, perhaps, the most conspicuous present example. A little later there came into existence for the first time continuous associations of employers.

With both parties organized and more nearly equal in strength, we seem likely to enter upon a new phase. Practically every capitalist and captain of industry has had the experience of the laborer, knows thoroughly this phase of life in at least one branch of endeavor, and looks forward to the probability of his great-grandchildren having to make their start from the same level. Practically no laborer has had the experience of the capitalist or of the captain of industry, and usually conceives a radically wrong picture of their activities, environment and motives. It is to these associations of employers, therefore, that we may look with hope for practical solutions of the questions involved.

Your association has now been in existence for nearly twelve years, and has published nearly 9,000 pages of proceedings. It is interesting to note that your activities have been directed in the following proportions:

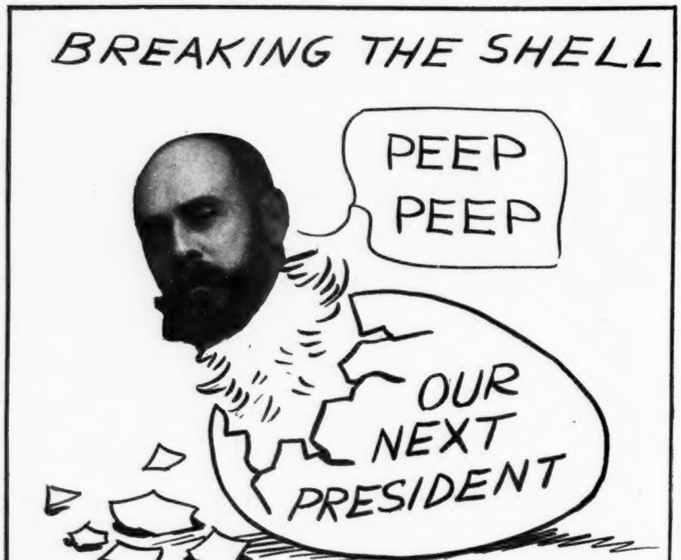
	Per cent.
On the problems of roadway	12
On the problems of track	30
On the problems of major structures	28
On the problems of minor structures	15
On the problems of miscellaneous	15
	100

If we reflect that the total maintenance of way expenses of the roads of the country are about $300,000,000 annually, and that of these expenses the moneys paid out for labor amount to 56 per cent, while all the other expenses amount to but 44 per cent, it would seem to justify the suggestion that your association devote at least a substantial part of your work to the study of labor. I would, therefore, urge that, to the present list of regular committees, there be added a committee on Maintenance of Way Labor, whose duties shall be to investigate the conditions of employment of and the relation of Maintenance of Way Labor to seasonal supply and demand; to consider questions of economic organization, education, discipline and equipment of forces for various kinds of work, and such other questions as shall from time to time be assigned by the usual authority.

Mr. Monk's Address.

I was immensely honored by the courteous and pressing invitation extended to me through your past president, my life long friend, William McNab. (Applause.) It was of a pressing nature, and as Mr. McNab is a Scotchman he could not be gainsaid. The many duties imposed upon me rendered it extremely difficult for me to come so far, but I am delighted to have come. I have been in public life for many years, but have never attended a gathering of such importance and of such a representative character; and permit me to add, coming to a strange country, I have never met with such a warm welcome, and I have never attended a banquet in such a magnificent edifice. There may have arisen some misapprehension as to the verdict rendered by our people in the recent election where the principal issue was the reciprocity matter. I come as a member of the party that fought that projected compact, as a member of the government called into power as the result of that election, and I come to assure you from the bottom of my heart that our people are as eager as they ever have been to maintain with our great neighbors of the south, with our cousins, with our brethren, the very best relations possible that should exist between two such nations. (Applause.) The purely business and economic consideration which we gave to the propositions laid before us are the only reasons which brought about the rejection of that proposition.

I have at times found, that the friendships I have made in this country, gave rise to the frank expression that you find we proceed slowly, at times, and the cause of this has been ascribed by my friends to the fact that we are still, in Canada, living in the colonial stage and under colonial conditions, which, to the mind of many Americans, means something similar to subserviency, and in a certain sense, slavery.



I would be pleased if I could by any words of mine dispel that impression. In our own country, under institutions somewhat different, perhaps, from your own, but in reality just as free, we enjoy at the present moment the same condition of freedom and mastership over our own destinies as you enjoy here in this great republic. It is very natural that you should have conserved a very keen recollection of those —what will I call them?—somewhat serious difficulties that occurred away back in the reign of King George III. Since those remote days the British institutions have undergone a vast change in the mother country and also in the great self-governing dependencies. You know what has happened since

the days when the legislative and the executive power were joined together in England; days of the existence of an aristocracy. During the 18th Century, under the first Reform Bill, under the second Reform Bill and under the final measure of emancipation, which was the Representation of the People Act, the power passed from the upper classes and was wielded in the mother country by the people at large. At the time when you found that the institutions which then ruled you, did not suit you any longer and made the mother country keenly aware of your dissatisfaction in that respect, a great change had begun even then in the mode of administration of the great dependencies of Britain, and that change has been going on ever since and to-day without any written instrument, these dependencies by common consent enjoy the fullest control over their own destiny.

I thought it proper to offer these explanations because we never can tell what are the immediate causes which lead the people to their decision in matters of general election. While we gave every consideration to the economic reasons which led us to reject the proposal, it must not be forgotten that for many years we ourselves had come to you with proposals which we had deemed in the interest of both countries and you had seen fit to reject those proposals.

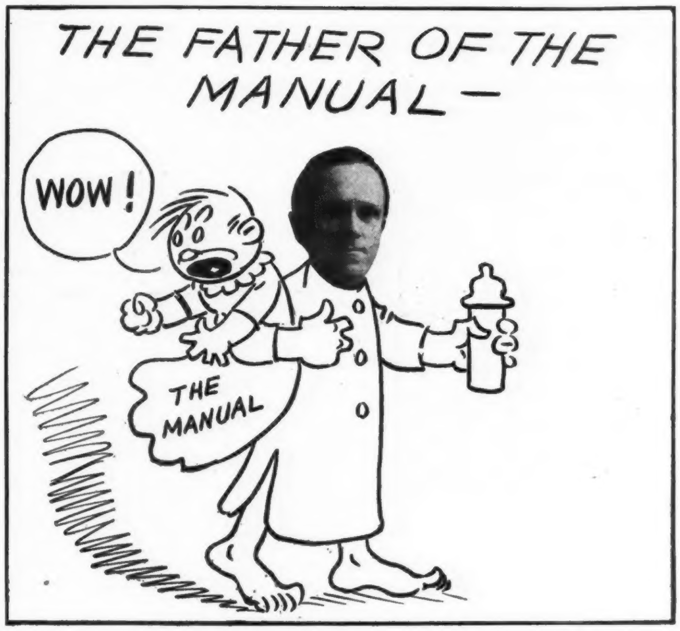
I may be entitled to offer you some word on the immense natural resources of the great country, great at least in extent and in those resources, from which I have come to be your guest this evening. If there is a paradise in the world for the noble class to which you belong and of which we stand in such great need upon this continent that paradise is surely in my own home of Canada, where we have resources almost limitless, great boundless forests still untouched by man, unexplored, silent, but teeming with riches of lumber, great mineral wealth still undiscovered, vast agricultural resources and problems of all kinds connected with the important question of transportation, the foremost problem before us for solution at the present moment.

At the present moment we have discovered—and I think this will be news to some of you—that the fertile belt lying to the north of the 45th line of parallel, is not as limited as it was. We have a vast interland where discovery and exploration has made known to us during the last three or four years that we have still boundless territories capable of immense production in an agricultural direction beyond what we formerly deemed land that could only be settled with fruit.

We have immense territory there and we are contemplating, gentlemen, in addition to the three great transcontinental lines which we are at present completing from tidewater of one ocean to tidewater on the other, the building of a great railway to the Hudson Bay to serve and take out the immense crops which we will be able to raise in this new interland of Canada.

We expect to navigate the Bay. It is navigable during six months of the year. The only question offered for solution is whether we will be able to get out through the straits, because that route will bring us nearer the markets of Europe than any other route in America. If we cannot during a sufficient time navigate those straits that are often blocked with ice, we expect by the facilities of navigation upon Hudson Bay to come down to Nottoway Port upon James Bay, a distance of 700 miles from the terminals upon the Hudson Bay for the great railway that will plunge into our new West to bring the products down to our own ports and to American ports. Another great problem which offers for solution is the construction of the Georgian Bay Canal at present engaging the serious attention of our government. You know that the St. Lawrence route is the great waterway extending from the ocean for hundreds and hundreds of miles into the very center of this continent. It is a waterway of supreme interest not only to ourselves, but to engineers of this country in common with us under treaties.

We are contemplating the construction of a deep waterway direct from the Great Lakes, over 20 feet deep, down to tide water of the Atlantic Ocean, which would bring the vessels of the Great Lakes over 700 miles nearer than by



the present St. Lawrence route, and shorten the passage 75 hours. A vessel could leave Chicago, fully freighted, drawing 20 feet of water, and convey, without trans-shipment, the immense loads of grain through the Great Lakes down to tide water and then further on to the ocean, and across the ocean and bring back return cargoes.

Not many years ago, conscious of the immense waste of the vast natural resources, common to both countries, your government initiated the movement of conservation. Delegates from our government, upon the invitation of your executive, went down to Washington to attend a conference, and most interesting measures were adopted there. A movement was started which has for its object the proper conservation and maintenance of these vast resources. After the starting of this epoch-making movement, our government instituted a most important commission called the Commission of Conservation. We divided the work of this commission, one section devoting itself to forestry, another section to public health, another to the study of our immense and still undiscovered mineral resources, another to the inventorying of our great fisheries, and another, with which I was particularly connected, to the study of our great water courses and water powers.

I was chairman of the Water Powers Commission or section and we applied ourselves to the immediate inventorying of those important forces and energies which we have at our disposal. The information regarding the developed water power in Canada is now fairly complete and reliable, and that which I have at hand shows a total of over one million horse power has already been developed. The following table shows how this developed power is divided among the different provinces:

Ontario	532,000 h. p. developed
Quebec	300,000 h. p. developed
British Columbia	100,000 h. p. developed
Manitoba	48,000 h. p. developed
Other provinces	33,000 h. p. developed

Of the different uses made of the water power, the generation of electrical energy heads the list with 75,000 h. p.; the paper and pulp industry has 150,000 h. p., and the remainder is divided among other industries, chiefly lumbering and grist mills. This total of over a million horse power

is being increased very rapidly by new enterprises, and, judging by the size which individual additions are assuming, it is fair to assume that it will be doubled in the course of a few years.

The information regarding the possible development of Canadian water power only covers a certain portion of the country. The total information obtained indicates that there is available 20,000,000 h. p., but as, roughly speaking, the territory covered is less than 50 per cent of the Dominion, it is fair to assume there is an equal amount in the part of the territory not included, which will bring the total for the whole territory to over 40,000,000 h. p. In stating this, however, it should be explained that, while the total horse power may be increased by utilizing storage batteries, many thousands of horse power cannot be utilized because too

small for economical development, and there are millions more of undeveloped horse power which are too far from settlements to be of any use if developed.

With the immense territory which we have, with pulp forest, sufficient, as I am informed, to supply the world with paper during ten centuries; with forty million horse power disseminated over this large territory; and with our great mineral resources, there is an immense field open to the men of your profession. Yours is the profession which we need most in my country.

Mr. Morris on Railway Development From a Banker's Standpoint.

I note with alarm that the program describes me as a banker, and director of the Railway Age Gazette. I don't know which job sounds the more dangerous, but it seems fairly obvious that to be a banker and a director, with an office on Wall street, or near it, renders me so peculiarly liable to imprisonment that I can only hope that no harm will come to your association through sheltering me this evening.

Apart from the directorate, the function of which is to declare dividends, I am sure that no one could work for the Railway Age Gazette as long as I have, without acquiring the most enthusiastic regard for the American Railway Engineering Association and the kinds of things it stands for. I have followed the red-and-white striped switch targets of the Chicago, Milwaukee & St. Paul across the continent, and the broad arrow and graphic whistle posts of the Southern Railway down into the mountains of Tennessee; I have seen the Southern Pacific Coast Lines wrestle with the problem of sticking a railway on top of slippery diagonal rock strata that loses its top layer every heavy rain and hasn't any bottom layer, and I have seen the Yazoo & Mississippi Valley build on brush mattresses and willow sprouts, and get away with it. In fact, I have never traveled over any railway without admiring the skill and courage and the resourcefulness of the civil engineer, under all the kinds of difficulties that this rocky and badly drained world has to offer.

And so, after leaving technical journalism to apply some of the principles learned in the apprenticeship, it is a particular pleasure to me to be the guest of your association—and a particular pleasure on top of that that I do not have to report this speech. Charles A. Dana once remarked to one of his reporters, "A dog bites a man; that isn't news. A man bites a dog; that's news." I am afraid the dog will have to do the biting in most of the comments I can make on a Banking View of Railway Development, but there may be some aspects of the situation which, even if not regardable as news, may be worth reviewing periodically.

My freshman year at college wasn't very long ago, but it ante-dated the automobile era. At that time there used to be in New Haven a pioneer of the industry, whose progress sounded much like a donkey engine running a pile driver. We used to bet whether or not it would pass a given point without stopping, or whether it would have battery trouble and stall, and stand while leaking gasoline. We all liked to see it go by, but I don't think any of us figured out that it typified a new era, not only of mechanical development, but of development in applied extravagance. Yet the increase in luxuries and in the money spent for them, during the fifteen years that have passed since that automobile went down the street, has doubtless been greater than in any other fifteen, or fifty years, in the history of the world.

This has hit railway development from two sides; it has necessitated luxurious cars, immense and costly stations and expenditure on hundreds of details of service not in themselves productive; it has also, with very little doubt, made it harder for securities to be marketed at the prices prevalent a decade ago.

I say "with very little doubt," because there is some ground for doubt as to the relative intensity of various other factors in the situation. The world is producing 450 million dollars' worth of gold a year, now; it is less than thirty years since the production was under 100 millions, and I think the radical increases of the last few years would have tended, anyway, to pull down the purchasing power of the gold dollar, and would have made things worth more, and mortgages and bonds worth less. A bond promises to pay in gold of a certain standard of fineness; not in the services, or coal, or potatoes you have to exchange that gold for.

Moreover, at the same time that the actual buying power of the dollar was growing less, the competition for the use of it was increasing with unheard-of rapidity, and a host of new industrial enterprises were bidding up the interest rate against each other. The railways, offering four per cent, saw the industrials offer five and six, and then the money was spent for a touring car that forthwith came back for more money—and got it.

Carry any discussion of applied economics very far, and the landscape grows monotonous. The sum of the matter is that high grade railway bonds sell on a basis to-day to yield the purchaser about 4¼ per cent on his investment, while ten years ago bonds of the same grade yielded about 3½ per cent, and, at the same time, the current purchasing power of the money obtained by the sale of the bonds isn't a bit more than four-fifths as great as it was in 1902. Combining these two scales, it appears that a road could hire $28.57 in 1902 for a dollar a year. In 1912 it can only get $18.82 worth of supplies and services for a dollar a year, if we assume that the services of a brakeman, or of a keg of spikes, are of the same value now that they were ten years ago.

This comparison ignores on both sides the banker's commis-

sion for the sale of the bonds. He probably didn't get as much as the newspapers said, anyway.

What relation is this statistical curiosity going to have to railway development? I have made it as black as I could, and have voiced the pessimism of many excellent observers, but my personal impression is that the matter will work out somewhat better than would appear, and that there are certain helpful aspects to the situation. I think the railways of the country can say with Josh Billings, that they have had a great deal of trouble in their life, most of which never happened.

It is going to be hard—it is already very hard—to finance speculative railway building, as one great speculative builder has recently found out. He addressed his newspaper advertisements against the Money Trust, when he was really up against automobiles and gold production, along with a habit of mind which a distinguished guest of the evening expressed to me with great clearness a short time ago. He said: "My impressions are that there is a Money Trust, and that it is made up of people who are not satisfied with receiving interest on their investments, but have a sneaking desire to get their principal back at maturity besides."

But there is another side to this situation which doesn't look at all bad for the credit of established railways. There are, in general, two kinds of investors, the man who wants security, and the man who wants yield. The number of roads that have gotten out of the speculative class and into the investment class during the last ten years is amazing, and the difference between those two classes is a lot more than the difference between 3½ and 4¼ per cent. And I think that, in the face of all difficulties, governmental as well as economic, that number is going to keep on increasing very fast, and that many roads, which to-day are struggling, are going to qualify in the investment class and stay there indefinitely. How old is the present credit of the Northern Pacific, or the Union Pacific, or the Southern Railway? Less than ten years, and the credit of the Erie is four years old this spring!

In other words, I think that the alignment between railway and industrial credit is now clearly fixed, and that the industrials are going to attract more and more of the speculative funds, while the railways will keep possession of a different and better market.

The amount of new funds raised for railway work in this country has averaged between 600 and 700 millions per year,

A PIPE DREAM

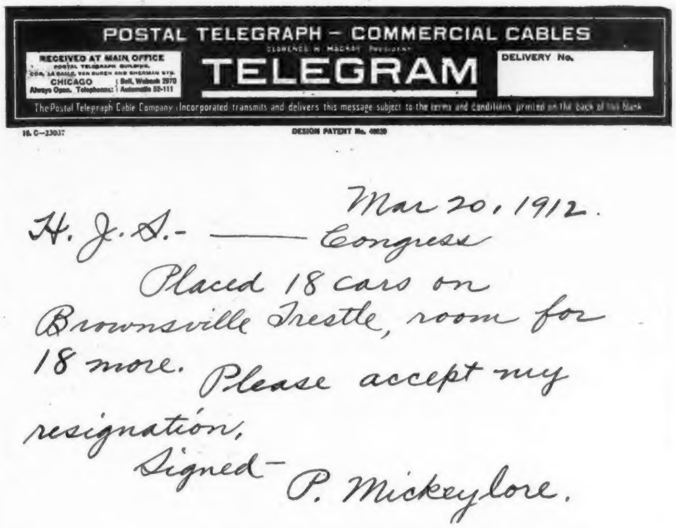
during the past six years. (This is money, not par value of securities.) I see no reason to doubt that the security markets of the world will go right on providing for legitimate work, in spite of the evident tendencies toward reduction of rates and higher operating costs. There has been much discouragement about the rate situation, especially right after 1907, when the national government was not strenuously sympathetic toward increases, while President Roosevelt's attitude toward those who might reduce wage schedules may be parodied by Lewis Carroll's lines:

"I'll take the corkscrew from the shelf,
And go and wake them up myself!"

I think we were all of us looking too close to the ground at our feet in 1908—I know the bankers were! Every decade of American railway development has seen rates on the whole lower and wages on the whole higher, and I guess every decade to come will see the same tendency. The adjustments are frequently painful, but increasing traffic density, which follows population, not legislation, takes care of that automatically. The average rates will be lower, but there will be more coal hauled, and more shirtwaists, and more groceries. And if special times of crisis make the adjustments temporarily unworkable, we can all sit back and bless the weak-sister roads—all the rest of us, that is—which can be relied on to furnish whatever object lessons may be required by an erring democracy, long before dividends are reduced on the strong roads in the same territory.

I am reminded of the district leader who was pointing out the debt we all owe to the poor.

"Let us not be stingy with the poor of our district," he


POSTAL TELEGRAPH – COMMERCIAL CABLES

TELEGRAM

DELIVERY No.

RECEIVED AT MAIN OFFICE

CHICAGO

The Postal Telegraph Cable Company (Incorporated) transmits and delivers this message subject to the terms and conditions printed on the back of this blank

DESIGN PATENT No.

Mar 20, 1912.

H. J. S.— —— Congress

Placed 18 cars on Brownsville Trestle, room for 18 more. Please accept my resignation.

Signed— P. Mickeylore.

said. "Let us be generous—nay, prodigal! And so I propose not one, not two, but three cheers for the poor of the district."

I think it would amuse most of my banking associates and all my Railway Age Gazette associates to hear me defend the Roosevelt administration, and yet there was one feature of it which appears to me to have peculiar weight at just this distance from the last first-class panic. After 1893 the railways were flat on their backs, financially, for nearly five years, because in the halcyon years that preceded 1893 they had overextended themselves tremenduously on faith in the future. But nobody did that in the Roosevelt administration, because nobody had any faith in the future! As a natural result, the years of convalescence since 1907 have really borne surprisingly lightly on the railways, and the few—the very few—really big new enterprises of the period, like the Puget Sound extension and the Western Pacific, have, with a single exception, remained solvent.

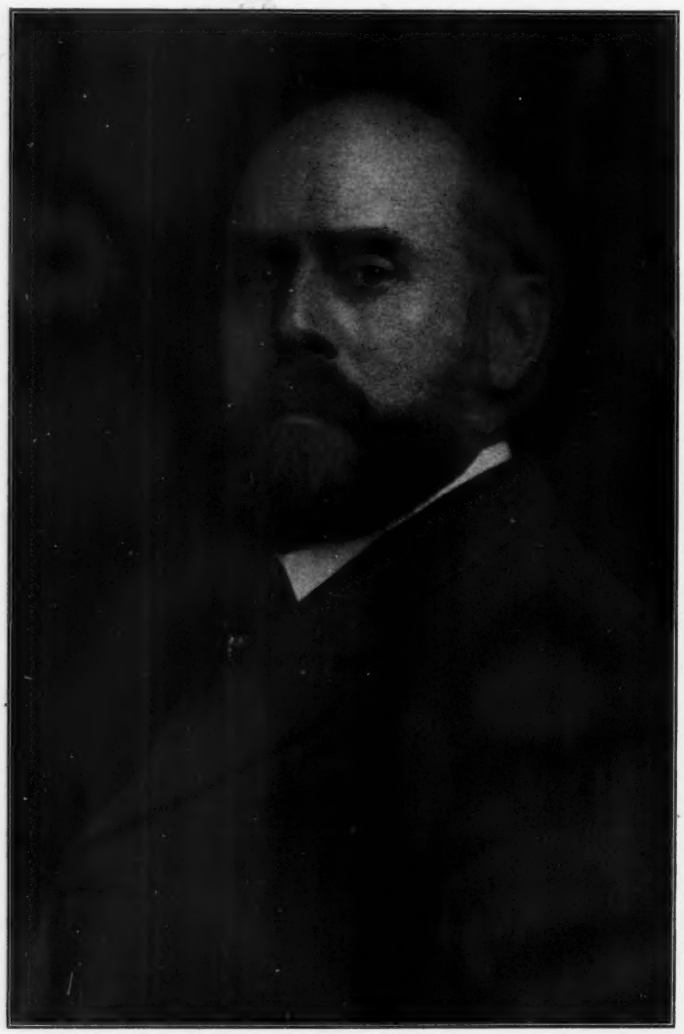
I suppose the long drag following 1907 is now pretty nearly over, and I think that the recovery is apt to be rapid, after the election is out of the way or discounted. The forms that the next high-prosperity period will take, in railway development, are a matter for interesting speculation. It seems to me that we are not likely to see great extensions into new territory, although Washington, Oregon and California are not quarter developed yet, as the rapid absorption of short lines in that territory well indicates. I should suppose that the internal growth of the Pacific states, following the opening of the Panama Canal, would be one of the great developments of the next decade—and I am not a bit afraid of the effect of the canal on railway traffic; quite the contrary, in fact. The recent prosperity of the South, it seems to me, may well foreshadow some realignment of railway interests there, accompanied by a renewal of competitive buying of the lateral lines, but probably not by much important new construction.

I should suppose there would be both construction and absorption in Texas and Oklahoma, and probably some important new family alliances among the roads now in the Gould grouping, together with great development of some of those properties, notably the Missouri Pacific, the Wabash and the Wheeling & Lake Erie. But I think the most important changes of all will be intensive, rather than

extensive, making for better built, better equipped and better signaled roads, and accompanied by materially better public feeling. The safety valve has opened, and the dangerous pressure has blown off. It made a lot of racket, but it didn't burst the boiler!

The Smoker.

At the conclusion of the speechmaking there was a smoker, the main feature of which was the throwing on a



CHARLES S. CHURCHILL.
President-Elect.

screen by means of a stereopticon of a number of cartoons of men whose faces are familiar to those who have attended the conventions of the American Railway Engineering Association. The cartoons were drawn by Artist French, whose work is familiar to readers of the sporting pages of the Chicago Record-Herald, the drawing being done directly on the plates of the lantern, so that the crowd could see it proceed. One of the cartoons was of "An All Star Cast," which included Past Presidents Wallace, Kittredge, McDonald, Kelley, Johnston, Berg, McNab and Fritch. "The Stamp of Approval" depicted the "A. R. E. A." putting its "O K" on President Cushing. Vice-President Churchill, elected to be the next president of the association, was depicted as just "peep, peeping" from the shell.

Vice-President Wendt, whose interest in the Manual is well known, was caught in the act of walking the floor with Baby Manual and a bottle of paregoric.

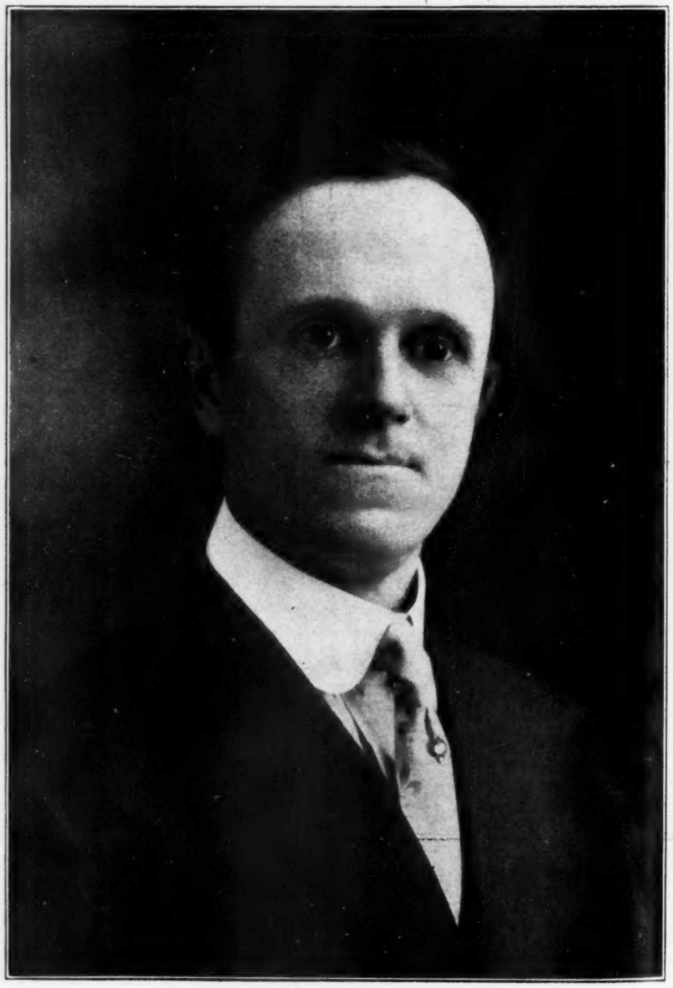
Mr. Bremner, the "bull-dog of the treasury," was represented as on guard protecting the cold cash of the association, while Secretary Fritch's bluff at taking vacations were shown up in their true light. The young engineer's pipe dream of $10,000 and a famous telegram from P. Mickeylore were reproduced and J. G. Sullivan, in the guise of "Officer 666," was represented as one who had "missed his calling." The artist threw on the screen the familiar words of the Missouri "dawg" song,

"And—every time I come to town
The boys start kickin' my dawg aroun'
I—don't care if he is a houn,"
They gotta quit kickin' my dawg aroun.' "

After the crowd had sung it he prescribed the following remedy: "And if you don't want him kicked around, buy a bull dog."

NEW OFFICERS OF THE ENGINEERING ASSOCIATION.

At the annual dinner last night President Cushing announced the election of the following officers of the American Railway Engineering Association for the ensuing year:



EDWIN F. WENDT.
First Vice-President.

President, C. S. Churchill.

Vice-President, W. B. Storey, Jr.

Treasurer, George H. Bremner.

Secretary, E. H. Fritch.

Directors for three years, F. A. Delano, W. L. Darling, W. B. Scott.

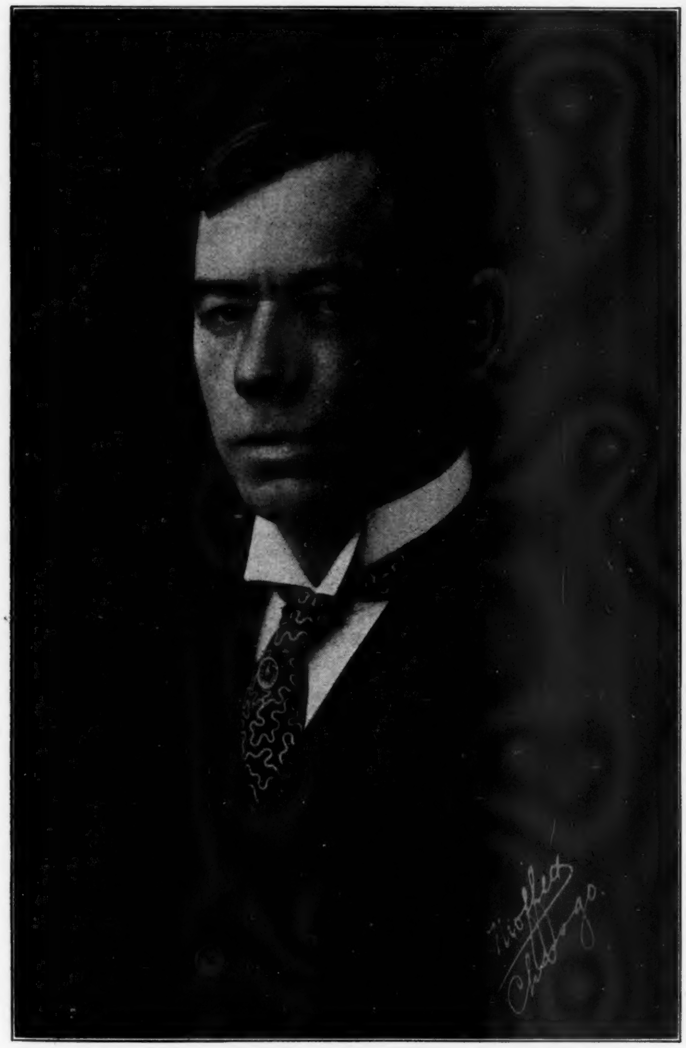
Nominating committee, F. L. Stuart, C. F. W. Felt, J. O. Osgood, G. J. Ray, F. H. Alfred.

FOREIGN RAILWAY NOTES.

In Madagascar, the only railway projected at present is the line from the port of Tamatadi, on the east coast, to Tananarido, the capital. This railway has not yet been entirely completed.

A fairly comprehensive scheme of railway development has been projected in Kamerun, Africa, but up to the present only about 280 miles have been opened to traffic. Two lines start from the coastal town of Duala. One railway is the Duala-Manengubaberge, of which 67 miles are open to traffic and 32 miles are under construction. The Duala-Edea-Widimenge Railway has 210 miles open to traffic and 53 miles under construction. Both these railways are of the 3 ft. 1 in. gage.

In Algiers the majority of the railway mileage is owned by the state. The Oran division is 620 miles long and is of the 3 ft. 3 in. gage. The eastern division has 500 miles of the 4 ft. 7 in. gage and 90 miles of the 3 ft. 1 in. gage.



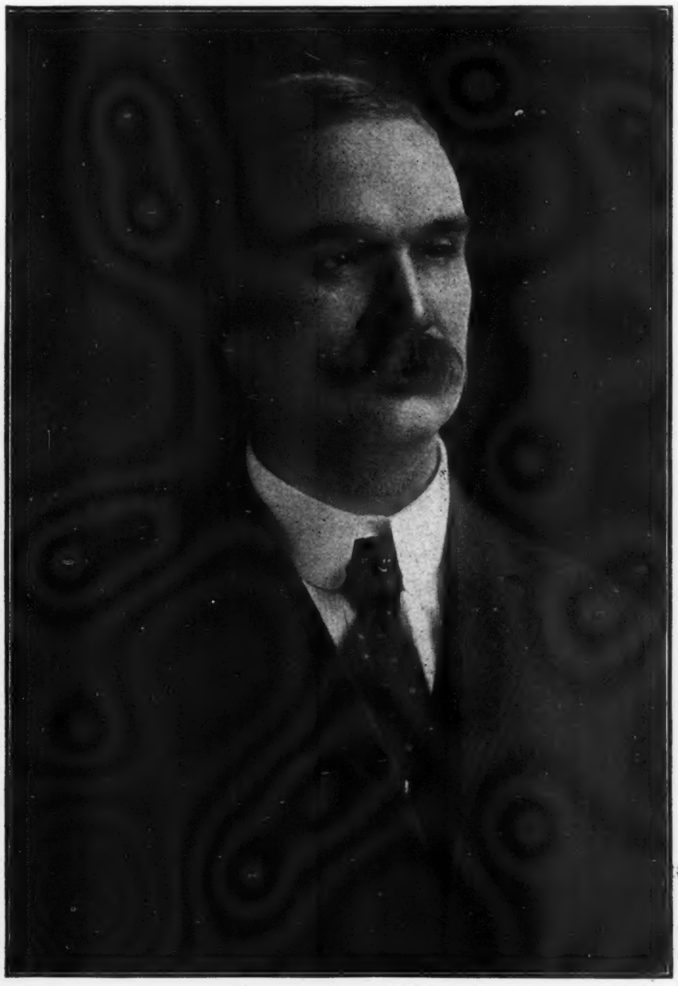
E. H. FRITCH.
Re-elected Secretary.

In addition, the former western railway system owned 280 miles of the 4 ft. 7 in. gage and 50 miles of the 3 ft. 3 in. gage. These are now operated by the state. The private lines in Algiers are the Algier-Oran, Philipp Eville-Constantine Railway, 314 miles long, of the 4 ft. 7 in. gage, and the Eone-Gulma and its extensions. This latter operates 378 miles of the 4 ft. 7 in. gage and 675 miles of the 3 ft. 1 in. gage, and, although nominally an Algerian line, 684 miles of the line are in Tunis.

CROSSTIES BOUGHT IN 1910.

The Department of Commerce and Labor has issued, under date of January 20, 1912, a bulletin relating to railway crossties purchased in 1910, and giving in considerable detail the latest statistics of ties used by the steam and electric railways of the United States. The following is an abstract of this bulletin:

The number of ties now in use or held for renewals on



G. H. BREMNER.
Re-elected Treasurer.

all classes of railways in the United States is probably not less than one billion.

Table 1 shows the number of ties purchased each year from 1907 to 1910, and their distribution according to the kind of wood, these kinds being arranged in the order of their importance in 1910.

Table 1.—Crossties Purchased, by Kinds of Wood: 1907 to 1910.

Kind of Wood.	Crossties Purchased (Number). 1910	1909	1908	1907
All kinds	148,231,000	123,751,000	112,466,000	153,703,000
Oak	68,382,000	57,132,000	48,110,000	61,757,000
Southern pine	26,264,000	21,385,000	21,530,000	34,215,000
Douglas fir	11,629,000	9,067,000	7,988,000	14,525,000
Chestnut	7,760,000	6,629,000	8,074,000	7,851,000
Cedar	7,305,000	6,777,000	8,172,000	8,954,000
Cypress	5,396,000	4,589,000	3,457,000	6,780,000
Tamarack	5,163,000	3,311,000	4,025,000	4,562,000
Western pine	4,612,000	6,797,000	3,093,000	5,019,000
Hemlock	3,468,000	2,642,000	3,120,000	2,367,000
Redwood	2,165,000	2,088,000	871,000	2,032,000
Gum	1,621,000	378,000	262,060	15,000
All other	4,466,000	2,956,000	3,764,000	5,626,000

In 1910 the steam and electric lines together purchased 148,231,000 wooden ties, or 20 per cent more than in 1909, and 32 per cent more than in 1908.

Of the total number purchased in 1910, only 8,635,000 ties, or 6 per cent, were reported by the electric roads. The statistics for 1910, which were secured by correspondence,

cover over 99 per cent of the known mileage of all railways in the United States.

Although by far the greater part of these purchases were for the maintenance of existing track, approximately 22,255,000 ties, or 15 per cent, were for new track. This percentage is the same as that reported in 1907, the year of the greatest total purchases, when 23,557,000 ties were bought for new track. In 1909 only 16,437,000 ties, or 13 per cent of the total number reported, were purchased for this purpose, and in 1908 only 7,431,000, or 7 per cent. Thus the statistics indicate a partial return in 1910 to the economic conditions encouraging track construction which prevailed in 1907.

Of the ties purchased by the electric railways in 1910, 2,656,000 were for new track, which number is slightly greater than those reported in 1909 and 1908, but only about seven-tenths as great as that in 1907, 3,835,000. In each of these years ties purchased for this purpose formed over 30 per cent of the total number shown for the electric railways.

The principal qualities desired in a tie wood are durability, spike-holding power and resistance to mechanical wear. The leading species used for crossties are mainly very durable woods, but the rank of the different kinds of wood thus used does not necessarily indicate their relative desirability for the purpose. The available local supply of timber largely determines the kinds used for ties in different parts of the country.

Many species of oak are first-class tie woods, and as a group they are more widely available than any other kind of suitable timber. As in previous years, oak and southern pine were by far the most important woods, supplying together nearly 64 per cent of all ties purchased in 1910. The number of oak ties reported, over 68,000,000, was the largest ever recorded for any kind of wood, being 20 per cent greater than in 1909. More than 26,000,000 southern pine ties were purchased in 1910, representing an increase of 23 per cent as compared with the preceding year. The proportions of the total formed by each of these kinds of ties were, however, practically the same in the two years.

With the exception of western pine, each of the 11 kinds of wood represented by over 1,000,000 ties supplied more ties in 1910 than in 1909. Except in the case of western pine, only fractional differences occurred between the percentage which each of the nine leading woods supplied of all crossties purchased in 1910 and the corresponding proportion for the preceding year.

Douglas fir was third in importance in 1910, as in 1909 and 1907. Since the supply of this species has scarcely been touched, the number of such ties will probably increase annually for a number of years.

Chestnut and cedar ties, ranking, respectively, fourth and fifth among the ties purchased in 1910, each constituted approximately 5 per cent of the total number. As compared with 1909, increases of 17 and 8 per cent, respectively, are shown for these classes of ties.

The number of cypress ties purchased, 5,396,000, showed an increase of 18 per cent since 1909, while the number of tamarack ties increased from 3,311,000 to 5,163,000, or 56 per cent.

In the purchases of western pine there was a heavy loss, 4,612,000 ties being reported in 1910, as against 6,797,000 in 1909. This decline is due mainly to decreased purchases of this species by one of the large western railroads.

Of the species which supplied less than 1,000,000 ties each in 1909, several showed heavy gains, the number of gum ties exceeding 1,000,000 for the first time in 1910, when 1,621,000 were purchased. Large increases were reported also for beech, maple, elm, spruce and birch.

Among the oak ties are included a number of imported Japanese oak ties. Altogether less than 2,000,000 ties were imported. Ohia lehua, a wood imported from Hawaii, is represented among the ties included under the head "All other." In this group are also included about 134,000 mesquite ties and ties of locust, hickory, cherry, sycamore, hackberry, walnut and several other species purchased in small quantities, principally by the steam railroads.

Of all crossties used, by far the greater number are hewed from the tree, a practice which involves great waste of timber. It is, however, gratifying to note that the proportion so produced in 1910 was the lowest recorded since annual statistics on the subject have been secured. Hewed ties formed 74 per cent of the total in 1910, as compared with 77 in 1909 and 82 in 1908. This decrease in the percentage of hewed ties is due principally to changes in the proportion of such ties among those made of oak and Douglas fir. Among oak ties the proportionate number of sawed ties has gradually increased since 1908, and the large increases shown since that year in the use of Douglas fir have been mainly in sawed ties, the number of hewed ties of this species having remained about the same each year.

A higher percentage of sawed ties in 1910 than in 1909 was shown also for chestnut, cedar, cypress, western pine and other less important woods. In most cases the tendency toward an increase in this class of ties is much more strongly brought out by comparison with 1907.

Douglas fir and western pine are the only woods from which a high percentage of sawed ties is at present produced, ties made by this method forming 88 per cent of the total number shown for the former and 49 per cent of that shown for the latter. It is noteworthy that these woods, which are supplying ties with little waste in manufacture, are likely to become of increased importance as future sources of supply for crosstie material.

The total quantity of ties purchased has not as a whole been much affected by changes in the cost of ties. The average price paid per tie was 51 cents in 1910, which is the same as in 1907, but greater than in 1908 and 1909, when the figures were 50 cents and 49 cents, respectively.

The number of ties of each kind of wood purchased in 1910 by the steam roads and by the electric roads is shown in Table 2:

Table 2.—Crossties Purchased, by Classes of Railroads Purchasing, and Kinds of Wood: 1910.

Kind of Wood.	Crossties Purchased (Number). Total.	Purchased by Steam Railroads.	Purchased by Electric Railroads.
All kinds	148,231,000	139,596,000	8,635,000
Oak	68,382,000	65,095,000	3,287,000
Southern pine	26,264,000	25,096,000	1,168,000
Douglas fir	11,629,000	10,919,000	710,000
Chestnut	7,760,000	6,219,000	1,541,000
Cedar	7,305,000	6,637,000	668,000
Cypress	5,396,000	5,187,000	209,000
Tamarack	5,163,000	4,960,000	203,000
Western pine	4,612,000	4,527,000	85,000
Hemlock	3,468,000	3,442,000	26,000
Redwood	2,165,000	1,501,000	664,000
Gum	1,621,000	1,621,000	....
All other	4,466,000	4,392,000	74,000

Since the steam roads purchased 94 per cent of the total number of crossties reported, the relative proportions of the different kinds of wood among the purchases of these roads were about the same as in the railroad industry as a whole. In the purchases of the steam railroads, 20 kinds of wood were represented by more than 100,000 ties each, while only 8 kinds of wood were so reported by the electric roads.

Preservation.

The deterioration of timber by preventable decay causes a heavy demand upon the timber resources of the country. In 1910 nearly 126,000,000 crossties were purchased to make renewals. By the adoption of devices to retard wear and methods to prevent decay, however, the present trackage could probably be maintained with approximately one-half the quantity of wood at present consumed annually for this

purpose. To employ measures which increase the average length of time ties may remain in service without decay is equivalent to increasing the supply of timber.

The principal causes of the deterioration of crossties are decay, insect attack, breakage, splitting, mechanical wear and respiking. By treatment of ties and the use of improved fastenings, S irons and similar devices, a mechanical life at least double the present average life of untreated ties may be secured. The treatment of ties to prevent decay, if the methods used are relatively inexpensive, results in a very great saving to the railways. In the United States the preservatives used for the greater number of the crossties are creosote oil or a solution of zinc chloride, although large quantities of ties are treated with a mixture of the two preservatives mentioned or with crude petroleum. Other preservatives are also used.

In general, the most effective method of treatment consists in the application of interior pressure to a cylinder containing the ties and the preservative. Ties are sometimes treated by merely dipping them in the preservative or by subjecting them to long hot and cold baths in open tanks containing the preserving fluid. In the latter process the impregnation of the wood is brought about largely by atmospheric pressure following the expulsion of air from the pores of the wood when heated and the subsequent tendency toward a vacuum when the wood is cooled. The absorption thus secured varies greatly according to the kind of wood treated. The kinds of wood commonly treated by the various methods are southern pine, Douglas fir, western yellow pine, red oak, black oak, beech, birch, maple, gum and hemlock.

Most of the treated ties used by the steam railways are treated in closed cylinders. Of 84 wood-preserving plants of the cylinder type in operation in the United States in 1910, the steam roads operated 21 and the electric roads 1, while the remainder, with a few exceptions, were conducted on a commercial basis.

The numbers of treated crossties reported in the years 1907 to 1910, inclusive, are shown in Table 3:

Table 3.—Crossties Purchased—Number Already Treated or Treated After Purchase, by Classes of Railroads Purchasing: 1907 to 1910.

Class of Railroad Purchasing.	Total Treated.	Treated Before Purchase.	Treated After Purchase.
		1910	
All railroads	30,544,000	11,644,000	18,900,000
Steam railroads	29,359,000	10,770,000	18,589,000
Electric railroads	1,185,000	874,000	311,000
		1909	
All railroads	22,033,000	7,663,000	14,370,000
Steam railroads	21,098,000	7,081,000	14,117,000
Electric railroads	835,000	582,000	253,000
		1908	
All railroads	23,776,000	10,973,000	12,803,000
Steam railroads	23,157,000	10,566,000	12,591,000
Electric railroads	619,000	407,000	212,000
		1907	
All railroads	19,856,000	8,389,000	11,467,000
Steam railroads	19,192,000	7,975,000	11,217,000
Electric railroads	664,000	414,000	250,000

In 1910 the number of treated crossties reported was over 30,000,000, which represents a gain of more than 8,000,000, or 39 per cent, over 1909, and a gain of nearly 7,000,000, or 28 per cent, as compared with 1908, when the figure was higher than in any other year prior to 1910. Since, however, the treated ties in 1910 represented but 21 per cent of the total number purchased in that year, it is evident that there is still a considerable opportunity for the further extension of this economy. Both steam and electric roads show great relative gains in the number of treated ties reported. Only 4 per cent of the treated ties shown for 1910 were purchased by the electric roads. Treated ties formed 21 per cent of the total number reported by the steam railways and 14 per cent of that reported by the electric roads.

Of all treated ties reported in 1910, about one-third were treated before purchase. The purchases of already treated ties had fallen greatly in 1909, but a comparison of the figures for 1910 and 1908 shows a complete recovery and some gain in this respect. The rapid increase in the number of ties treated, however, is due mainly to the increasing numbers treated each year by the steam roads in their own plants. Only 26 per cent of the treated ties reported in 1910 by the electric lines were treated after purchase, while for the steam railways the percentage was 63.

BLOCK SIGNAL INSPECTORS HERE.

Block Signal Inspectors Lyons and Burt of the Block Signal and Train Control Board have been making a study of the many improvements in signaling apparatus on display at the Coliseum, with special reference to automatic signals and their workings.

IMPROVEMENTS FOR THE SANTA FE SYSTEM.

The Atchison, Topeka & Santa Fe system has appropriated $22,700,000 for improvements this year, which will include a very large amount of expenditures in the engineering department.

Although all of the details of the improvement program have not been announced, the budget includes $2,000,000 for double-tracking on the Coast Lines, $1,000,000 for terminal yards and improvements on the Colorado division, and $500,000 for a new office building at Galveston, Tex. For new equipment $5,700,000 will be expended, and the balance of the $22,700,000 will be devoted to general improvement work throughout the system.

Contracts have been let for the double-tracking between Baca and Perea, on the Albuquerque division, 28 miles, and from Needles east 10 miles on the Arizona division. The only new construction planned so far for this year is the line from Dodge City, Kan., southwest 60 miles.

The new equipment will include 75 passenger cars, 2,850 freight and work cars and 75 locomotives.

EXIT WINTER—NOT!

At noon yesterday Miss Gentle Spring officially assumed possession of the city of Chicago and the adjoining states. Winter the March Lion, and Willis L. Moore delivered over the keys, as per the schedule made and provided by the Equinoxes and the Solstices, who regulate the changing of the seasons. Miss Spring's suit in ejectment was, therefore, not necessary and the action was not brought.

Winter and the Lion had just started north, however, when they received the following telegram:

"Medicine Hat, Midnight, March 19.

Tear things up a little before you leave.

Storm King."

This they proceeded to do immediately, and all day yesterday they put forth their utmost efforts to make a good job of it. Reinforcements in the shape of a full grown blizzard arrived early in the morning, and all day the three proceeded to tie up traffic, fill the streets with snow, spread pneumonia, and destroy good tempers.

Miss Spring regrets exceedingly this spiteful exhibition, inspired from Medicine Hat, and against her will has been forced to file an action in trespass against the invaders of her domain. If the testimony of character witnesses is to be used the defendants will make a sorry showing, indeed, for in all the length and breadth of the United States they haven't a friend.

Many of the engineers attending the convention who are residents of Iowa, or who formerly lived in that State, attended a banquet of the Hawkeye club at the University Club last evening.

CONFERENCE ON STANDARD INTERLOCKING RULES.

Representatives of the railway commissions of Indiana, Illinois, Wisconsin and Minnesota will hold a meeting to-day at the office of F. G. Ewald, consulting engineer for the Illinois Commission, Chicago, to complete the formation of standard interlocking rules for the railways in those states. These rules will be submitted to the commissions, and will be followed up in the near future by standard automatic block signal requirements. M. H. Hovey, consulting signal engineer, represents the Indiana and Wisconsin commissions, D. F. Jurgensen the Minnesota commission and F. G. Ewald the Illinois commission.

THE FIRST-NAME CLUB.

A new club has been started among railway and supply men. The constitution provides that members shall call each other only by their first names. It contains, also, the provision that members shall be taken in by one name at a time, and until all of that name have been enrolled no one else is eligible. Inasmuch as four "Harolds" originated the idea that name is the first one. Harold Lowry, assistant signal engineer of the Chicago, Milwaukee, & St. Paul; Harold McCready, of the Union Switch & Signal Co.; Harold Brown, of the Pocket List; and Harold Ferguson, of the General Electric Co., held the first meeting of the club Tuesday night. If your first name is Harold write to any one of the above mentioned members and get in.

ELECTRIC RAILWAY MEN IN TOWN.

The fact that the exhibit at the Coliseum includes more electric railway apparatus this year than in previous years has attracted a good many officers of electric roads. Among the visitors yesterday were General Superintendent Kerwin of the Detroit United Railways; Assistant General Manager Gould of the Aurora, Elgin & Chicago; C. D. Emmonds, vice-chairman and general manager of the Chicago, South Bend and Northern Indiana Traction Co.; C. F. Conn, vice-president and general manager, Lackawanna & Wyoming Valley Railroad Co.; and B. E. Merwin, general superintendent, Aurora, Elgin & Chicago. John Leisenring, signal engineer and superintendent of overhead of the Illinois Traction System, and J. M. Waldron, signal engineer of the Interborough Rapid Transit, New York, are also here attending both at the convention and the exhibition.

There is to be a meeting of the Illinois Electric Railway Association at the La Salle Hotel Friday morning. This meeting was postponed from last Friday so that the members attending could take advantage of the exhibition.

ATTENDANCE AT THE COLISEUM.

The blizzard yesterday afternoon cut into the attendance somewhat, and there were not as many railway men present as on the previous day. But those who did come took advantage of the opportunity to study the new developments in apparatus and equipment.

Among the exhibits which seemed to be objects of special attention were those of the signal companies, where some remarkable developments are shown in interlocking machinery, automatic block signal mechanisms and other apparatus. It seems that there are more prime-movers in operation this year than ever before, and the applications of electricity to exhibit apparatus, such as flashing signs, are much in evidence. The decorations and arrangements of the exhibits are effective, and in so far as a collection of machinery can be said to be artistic most of the exhibits may be so characterized. Gasoline engines, generating sets, mercury and rectifiers, automatic signals of half a dozen types, illuminated flashing-light crossing signals, crossing bells, track and tie drilling machines, air compressors, and many other kinds of apparatus are constantly in operation, and in one exhibit something new in the way of lightning arresters actually working in the same manner as they do when installed on signal and telegraph circuits is also to be seen.

Among those who wander in and out, and do not say much but do a lot of observing, quite a number of the executive and purchasing officers of railways in Chicago have been recognized, although in some cases they were, perhaps, a little bit unwilling to admit it. At least four purchasing department officers, four superintendents, two general superintendents and three assistant general managers visited the exhibit yesterday forenoon.

Railway men watched the blizzard all afternoon for fear that it would assume such preportions that they would have to be on hand to keep the tracks open tonight. That is probably the principal reason why the attendance was rather small yesterday.

BROKEN RAILS—A RETROSPECT.

The attention which is now being given to the study of broken rails makes it interesting to look back to the condition of things nearly forty years ago. What that was we may learn from the record of train accidents, which was begun by the Railroad Gazette in 1873. This record was compiled chiefly from the newspapers, and, of course, included few accidents which did not make trouble enough to call for comment by them; that is, its errors were chiefly errors of incompleteness.

Now, in the year 1873 about 67,000 miles of railway were in operation in the United States, with traffic per mile probably much less than half what it is now. Last year more than 245,000 miles were in operation. Yet in 1873 the Railroad Gazette recorded 1,283 train accidents, of which 815 were derailments. The causes were reported for 500 of these derailments, and 111 were occasioned by broken rails. The winter had been unusually severe, and the frequent breakages were charged to the effect of the cold on the rails, then nearly all iron, and for the most part very poor iron. The iron, doubtless, deserved its discredit; but probably more of the breakages were due to the condition of the roadbed, then in many cases unballasted or imperfectly ballasted, freezing like a rock, with uneven bearings under the rails.

The effect of the cold was traced by the Railroad Gazette in its review for 1877, when it showed the number of accidents caused by broken rails in the cold (first) quarter of the year compared as follows with the number in the third quarter (July, August and September):

	1873.	1874.	1875.	1876.	1877.	5 years.
First quarter....	65	20	90	26	26	227
Third quarter...	5	5	3	5	7	25

This showed that on the average there were nine times as many broken rails in the cold season as in the warm one; while in the exceptionally cold winter of 1873 there were 13 times as many, and in that other severe winter, 1875, 30 times as many. In 1877 there was but one exceptionally cold month, yet in that month there were 17 accidents caused by broken rails—more than one-third of the number for the whole year.

This is, of course, ancient history. Roads, rolling stock and traffic all are different now, and a modern heavy locomotive would have broken nearly every rail on some of the rough tracks of 1873. But it may prevent discouragement to realize that, although we have not reached perfection in rails and roadbed, we have at least made progress.

INFLUENCE OF ROLLING TEMPERATURE ON THE PROPERTIES OF BESSEMER RAILS.*

BY M. H. WICKHORST,

Engineer of Tests, Rail Committee.

1. This report covers an investigation to throw light on the influence of the rolling and finishing temperature on the properties of Bessemer steel rails. A series of five ingots from one heat of Bessemer steel was rolled into 85 rails, all in a similar manner, except as to the temperature at which they were rolled. One ingot was rolled "cold" and the temperature was increased with the succeeding ingots, finally rolling the last ingot very hot. The ingots were about 18½ in. by 19½ in. at the bottom, about 51 in. high and weighed about 4,400 lbs. each. After soaking in the usual manner, the ingots were rolled into blooms about 9½ in. square and a smaller discard than usual made from the top. Each bloom was then cut in two, the two parts reheated at the same time, and were rolled into 85-lb. P. S. section rails (Pennsylvania Railroad System), four rails being made from each ingot. In addition one ingot of the same heat was used for splitting open and making a chemical survey, this ingot having been placed in the soaking pit and then cooled down. This work was all done at the works of the Carnegie Steel Company, who kindly furnished all the material and facilities for the test work.

2. The rails were examined by means of drop, tensile and microscopic tests. The comparison ingot was split open to determine the interior condition as regards cavities, and analyses were made of about 75 samples from one side of a longitudinal section near the axis to determine the distribution of the carbon, phosphorus and sulphur.

3. The shrinkage after sawing varied from 6¼ in. in a 33-ft. rail, as the average of the four rails from a whole rail-bar, to 7 in. The temperature of the head of the rail just after leaving the finishing rolls, determined by a heat radiation pyrometer, varied from 940 deg. C. to 1,030 deg. C., a range of 90 deg. C.

4. The upper 15 per cent of the comparison ingot was spongy with blow holes generally distributed, and the central cavity extended downward about one-third way from the top.

5. The axis of the ingot showed considerable segregation of the carbon, phosphorus and sulphur, reaching a maximum at about 15 per cent by distance from the top. The maximum increases found were 72 per cent in carbon, 98 per cent in phosphorus and 79 per cent in sulphur, above the average content of the ingot. The axis also showed a little negative segregation in the lower part of the ingot.

6. The walls or outer part of the section showed negative segregation at the top part of the ingot for a distance of about 15 or 20 per cent down, after which the composition is about the average to the bottom of the ingot. The greatest decreases amounted to 16 per cent in carbon, 27 per cent in phosphorus and 31 per cent in sulphur below the average content of the ingot.

7. The ductility in the drop tests was determined by putting gage marks one inch apart for a distance of three inches each side of the middle longitudinally on the side in tension, and measuring the space which stretched most at failure.

8. The tests covered the rail-bar from about 10 per cent from the top down to about 90 per cent from the top, and the remarks below refer to this part of the rail-bar. In both head tension and base tension tests the ductility, as an average of all the rail-bars, increased continuously along the rail-bar, starting from the top end. With head tension the range was from about 8 per cent to about 27 per cent and with base tension from about 12 per cent to about 24 per cent.

9. The permanent deflection or set was measured under the first blow of a 2,000-lb. tup falling from a height of 18 ft., with a span between supports of 3 ft. The set measured was the distance between a 3-ft. straightedge and the part of the rail where struck by the tup.

10. As an average of the head tension and base tension results, the set at about 16 per cent by weight from the top of the ingot was 1.69 in. and increased continuously down the rail-bar until at 90 per cent down it was 1.81 in., an average increase of about 7 per cent, although the rate of increase varied in different parts of the bar. The set with the head in tension averaged about .04 in. greater than with the base in tension. The results from the bar above 16 per cent from the top were insufficient to allow of conclusions, but it seems that the set was greater than at 16 per cent down.

11. Differences of rolling temperature corresponding to shrinkages of 6¼ in. to 7 in., in a 33-ft. rail, resulted in only small differences in the rails as determined by the drop test. The deflection seems to have increased slightly as the temperature increased, the averages of the bars ranging from 1.73 in. to 1.78 in. The ductility also seems to have increased some with an increase of temperature of rolling, ranging from 18.7 per cent to 21.1 per cent for the averages of the bars. The number of blows that it took to break the rails averaged just about the same for the different bars, namely, 3½ blows.

12. Tensile tests were made along the rail-bars from three locations in the section, the corner of the head, the interior of the head near its junction with the web, and the flange.

13. Considering the average results of the five bars, the yield point and tensile strength were about uniform along the bar in the samples from the corner of the head and the flange, with perhaps a slight upward tendency down to about 20 per cent from the top. The flange averaged about 2,000 lbs. higher than the corner of the head both in yield point and tensile strength, the yield point averaging about 68,000 and 66,000 lbs., respectively, and the tensile strength about 120,000 and 118,000 lbs., respectively.

The yield point and tensile strength of the interior of the head at first increase to above the results from the two other locations, and in the lower part of the ingot they are less, corresponding in a general way to the distribution of the hardening elements, carbon and phosphorus.

14. The elongation and reduction of area of the corner of the head and the flange increased continuously, in a general way, downward of the ingot, the corner of the head showing a little higher in both properties than the flange. In the corner of the head the elongation averaged from 15 per cent in 2 in. to 18½ per cent, between the limits of 10 per cent and 85 per cent down from the top of the ingot and in the flange the results were about 1 per cent lower. The reduction of area in the corner of the head ranged from 21 per cent to 30 per cent in the same region, and in the flange it averaged about 2 per cent less in the upper part of the ingot, but about the same in the lower part.

In the interior of the head the elongation and reduction of area started at upper part of the ingot about the same as in the other locations, but they soon fell off to only a few per cent at about 15 per cent down, after which they increased, and in the lower half of the ingot they were about the same as in the corner of the head and the flange, or were a little higher.

15. Differences of rolling temperature corresponding to shrinkages of 6¼ in. to 7 in. in a 33-ft. rail, resulted in little or no differences in the yield point. The tensile strength was likewise not influenced, except that the flange seems to have increased a little in tensile strength as the temperature of rolling increased.

16. The elongation of the corner of the head and the flange decreased a little with increase of temperature, but the interior of the head decreased more in elongation with increase of temperature, ranging from about 16.5 per cent in 2 in. at 6¼ in. shrinkage to about 12.8 per cent at 7 in. shrinkage.

17. The influence of the temperature of rolling, as determined by the tensile test, is seen most prominently in the reduction of area, which decreased as the temperature increased. The range in the corner of the head was from about 29.3 per cent at 6¼ in. shrinkage down to about 24½ per cent at 7 in. shrinkage, in the flange from about 26.7 per cent to about 23.7 per cent and in the interior of the head from about 24.2 per cent to about 17 per cent.

18. A discussion is given comparing the ductility as developed by the drop test and the tension test. In both tests the ductility increased in a general way, downward of the ingot, except that the ductility of the interior metal in the tension test was at its minimum at about 15 per cent from the top. The exterior metal shows good ductility, as shown by the tension test, along the whole rail-bar, but the interior metal is of very low ductility at about 15 per cent by weight from the top. This seems to show its influence in the drop test, to some extent in the tests with the base in tension, but more prominently in the tests with the head in tension.

19. Microphotographs were made of etched sections from three locations in the section; namely, the upper corner of the head, the interior of the head near its junction with the web, and the flange. As the rolling temperature increased, the number of grains per unit of area decreased, that is, the size of the grain increased. In the flange the

*From Appendix E of report of Rail Committee.

number of grains per .001 sq. in. averaged from 138 with the lowest temperature used to 55 with the highest temperature used. In the corner of the head the range was from 100 down to 56, and in the interior of the head from 59 to 21.

20. Finally, the influence of the temperature of rolling, as ascertained by the tests made, may be summed up, as follows: The ductility and deflection in the drop test were influenced little, if any, by the temperature. The number of blows that it took to break the rails in the drop test was uninfluenced by the temperature of rolling. The yield point and tensile strength in the tension tests were influenced little, if any. The elongation in the tension test decreased some as the temperature increased. The influence of temperature showed most prominently, in the tension test, in the reduction of area, which decreased as the temperature of rolling increased. The size of grain, as shown by the miscroscope, increased as the temperature increased.

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Tordella, J., Div. Eng., B. & O. R. R., Garrett, Ind.
Turneaure, F. E., Dean, Col. of Engr., Univ. of Wis., Madison, Wis.
Watson, P. J., Jr., Asst. Eng., W. & L. E. R. R., Canton, Ohio.
Webb, G. H., Chief Engineer, M. C. R. R., Detroit, Mich.
White, R. C., Division Engineer, Mo. Pac. Ry., Little Rock, Ark.
White, R. M., Supt., D. L. & W. R. R., Easton, Pa.
Wiggins, W. D., Div. Eng., Penna. Lines, Pittsburgh, Pa.
Willis, R. W., Eng., Mo. Dist. C., B. & Q. R. R., St. Louis, Mo.

GUESTS.

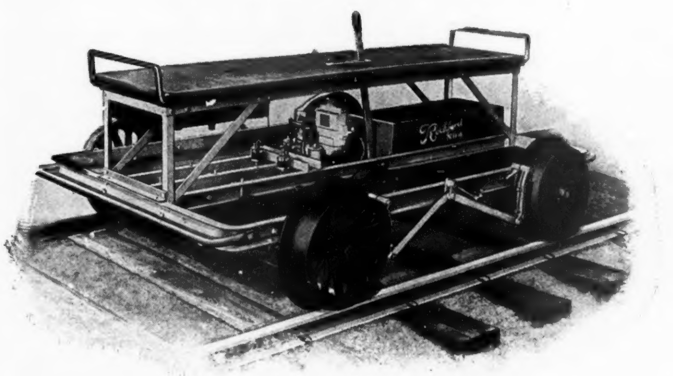
Kimble, W. P., Div. Eng., Erie R. R. Marion, Ohio.
White, R. B., Supt., C., H. & D. Ry., Indianapolis, Ind.
Cossil, H. A., Div. Eng., C., H. & D. Ry., Indianapolis, Ind.
Fletcher, J. E., Supt., Erie R. R., Galion, Ohio.
Cothers, F. S., Asst. Div. Eng., Erie R. R., Marion, Ohio.
McFarland, J. A., Chemist and Eng. of Tests, Frisco R. R., St. Louis, Mo.
Schmidt, Edward C., Prof. of Railway Engineering, Urbana, Ill
Young, J. B., Chemist, Phila. & Reading Ry., Reading, Pa.
Rogers, E. O., Sig. Supt., Erie R. R., Marion, Ohio.
Quick, L. S., Div. Claim Agent, Erie R. R., Marion, Ohio.
Young, C. D., Eng. Tests, P. R. R., Altoona, Pa.
Cuthbert, A. B., Prin. Asst. Eng., P. R. R., Altoona, Pa.
Holtsberry, D. C., Div. Eng., Toledo & Ohio Cent. Ry., Bucyrus, Ohio.
Moses, L. B., Kettle River Co., St. Louis, Mo.
Pooler, F. S., Tie Agt., C., M. & St. P. Ry., Chicago, Ill.
Hadwen, L. D., Eng. Masonry Construction, C., M. & St. P. Ry., Chicago.
Leckie, A., Div. Eng., K. C. S. Ry., Pittsburg, Kan.
Jackson, A. A., Asst. Eng., B. & O. R. R., Baltimore, Md.
Spieth, O. C., Asst. Div. Eng., B. & O. R. R., Cleveland, O.
Dawson, W. R., Asst. Supt., N. & W. Ry., Bluefield, W. Va.
Ayres, L. C., Asst. Supt., N. & W. Ry., Portsmouth, Ohio.
Fowler, H. E., Asst. Div. Eng., B. & O. R. R., Wheeling, W. Va.
Barnhart, E. H., Asst. Div. Eng., B. & O. R. R., Newcastle, Pa.
Shea, John, Roadmaster, D. & I. R. R. R., Two Harbors, Minn.
Williams, A. P., Asst. Div. Eng., B. & O. R. R., Collinsville, Pa.
Stewart, S. G., Kansas City Terminal Ry., Kansas City, Mo.
Sargeant, J. E., Pm. Agt., St. L. & S. W. Ry., St. Louis, Mo.
Williams, W. J., Supt. Telegraph, St. L. & S. W. Ry., St. Louis, Mo.
Mace, M. E., Supr., K. & M. Ry., Charlestown ,W. Va.
Espenshade, E. B., Civil Eng., Chicago, Ill.
Ward, C. H., Roadmaster, K. & M. Ry., Middleport, Ohio.
Eberst, Paul, Foreman, B. & B., K. & M. Ry., Middleport, O.
Millner, E. D., Civil Eng., Chicago, Ill.
Bather, C. S., General Frt. Agent, Texas City Terminal Co., Texas City, Texas.
Brown, George M., Asst. Ch. Eng., Pere Marquette R. R., Detroit, Mich.
Middletown, R. J., Valuation Eng., C., M. & St. P. Ry., Chicago, Ill.
Gennett, C. W., Jr., Robt. W. Hunt & Co., Chicago, Ill.
Osborne, C. G., Ch. Eng., Illinois Steel Co., Chicago, Ill.
Hatbridge, J. T., Con. Eng., Chicago, Ill.
Steenbergen, W., Asst. Eng., K. & M. Ry., Point Pleasant, W. Va.
McCoy, J., Transit Man, A., T. & S. F. Ry., Marceline, Mo.
Walton, N. H., A., T. & S. F. Ry., Marceline, Mo.
Duncan, J. F., Transit Man, A., T. & S. F. Ry., Marceline, Mo.
Dickson, J. H., Supt. Creosoting, Can. Pac. Ry., Winnipeg, Can.
Brennon, C., Asst. Eng., C. & E. I. R. R., Evansville, Ind.
Ray, W. M., Asst. Eng., B. & O. R. R., Cleveland, O.
Kellehar, W. J., Pm. Agt., N. O. & N. Ry., New Orleans, La.

At the Coliseum

ROCKFORD SPIKE DRIVING CAR NO. 6.

The Rockford screw driving outfit is a complete, small power plant for electrically driving spikes. It is entirely self-contained, is self-propelling and has ample carrying power and space for a crew of men and the necessary tools. The outfit consists of engine, dynamo, switch-board, 500 ft. of cable and the necessary electric drills for this service. These parts are mounted upon a frame built of 3-in. steel channel welded autogenously into a solid, rigid unit. This frame rests on four-leaf, semi-elliptical steel springs supported by saddles on the axles of the car. The axles are made of double heat treated, open hearth steel 1¾ in. in diameter. The axle boxes have removable babbitt bushings and are self-oiling from a recess filled with oil. The car is equipped with pressed steel wheels, 16 in. in diameter and having M.C.B. flanges. The platform of the car is 7½ ft. in length inside the channel frame and is 50 in. in width. The working parts are mounted on two channels running the long way of the frame and thus occupy the center of the car.

A two cylinder, double opposed, four cycle gasoline engine supplies power for the entire outfit. It is air-cooled



Rockford Spike Driving Car No. 6.

without fans or any special equipment and develops 10 H. P. running at 1,000 revolutions per minute. Ignition is from a high tension magneto, no batteries, spark coil or timer being used. The engine is equipped with a Schebler carburetor, having a special automatic throttling attachment which takes care of any variation in load by regulating the gasoline supply. Two levers—one for the spark and the other for the throttle—make up the control; and these levers are so located as to be easily accessible to the operator. The engine is lubricated from a large oil cup centrally located over the crank case and having leads to small sight feed cups on the cylinders and bearings. The operator of the car can always determine at a glance whether or not oil is feeding properly.

The engine, as a whole, is strong, compact, reliable, easily operated and designed for continuous service. The gasoline tank has a capacity of 20 gallons and the oil cup holds oil enough for eight or ten hours' running. Every part of the engine is easily accessible to the operator of the car, and it is simple both in design and operation. The carburetor adjustment is automatic when the dynamo is being driven and the high tension magneto used for ignition is the same igniter which is used upon all Rockford cars. It is entirely enclosed, has no adjustments and no electrical contacts and only two wearing parts. The dynamo is direct driven from the engine, through a double friction clutch which permits of running the engine without driving the dynamo when the car is moving.

For driving the car itself there is a sprocket attached to one drum of the clutch between the engine and dynamo. This sprocket carries a short chain which drives a sprocket on the transmission shaft. The shaft is fitted with a forward and reverse gear and a band brake. The gear and brake are controlled by one lever which has three positions. The central position of this lever sets the brake, thus making it impossible, under any conditions, to go from forward to reverse or from reverse to forward without applying the brake. The movement of the lever from either position will set the brake.

The rear or drive axle of the car is driven from the transmission shaft by spiral gears entirely enclosed and running in oil. The clutch, reversing gear and chain are also entirely enclosed. The type of transmission used prevents any violent shock or jar when the car is started, insuring steadiness and reducing wear to a minimum.

A reel holding 500 ft. of cable is mounted on the car. The standard spike driving outfit consists of two Duntley electric spike drivers, four Duntley electric wood boring machines and a Duntley electric grinder for grinding the tools. Seventy-five ft. of cable is attached to each spike driver, giving a range of action of 1,150 ft.

On one of the large steam railways one of these outfits has been driving 3,500 screw spikes per day with a short run record of 540 spikes per hour.

SECTIONAL STEEL STORAGE HOUSES.

The use of sectional steel buildings for the storage of cement and other materials is a recent development in the railway field which should meet with favor. In construction work it is necessary to erect temporary shops for the storage of material, etc. The first cost of such buildings of frame construction, as they usually are, is high, while the expense of erection and the loss and deterioration in material

Sectional Steel Storage House.

in tearing down and moving to another location is heavy. The use of a sectional steel building, such as that put out by the Ruby Manufacturing Company, Jackson, Mich., which is illustrated here, should prove economical. Being built in interlocking sections it can be readily uncrated and erected where desired, furnishing a rigid and waterproof building. It can be taken down in a short time and moved to a new location and put up again without any loss in material and at a saving in labor over that necessary to move a frame building. This type of building has come into use on sev-

eral electric lines and it should also be of advantage in the steam railway field.

GASOLENE ELECTRIC TOOL CAR.

The Otto Gas Engine Works, Philadelphia, Pa., recently put on the market a section motor car of a novel design. This car is known as the Otto gasolene electric tool car. Its purpose is to convey men and tools to the work on the section with greatest convenience and speed and then supply the necessary power to operate electric tools. The motive power is supplied by a 30-h. p. four-cylinder, four-cycle gasolene engine. An electric generator is operated by the same engine which propels the car. Eight or ten men can be conveniently carried with tools, and additional cars can be readily coupled to carry material, additional tools or men.

The car is operated like an automobile. When the driver throws the clutch into engagement with the engine to run the car, the generator is disengaged; and when the car reaches the point of operation the engine is disengaged from the transmission and engaged to the generator. To eliminate the necessity of constantly moving the car along the track to operate the electric tools, a quantity of cable is carried, which can be laid as far as a quarter of a mile in any direction from the car. About 20 ft. apart on this cable are

Gasolene Electric Tool Car.

plug-in switches, and each electric portable tool is equipped with a special stage plug.

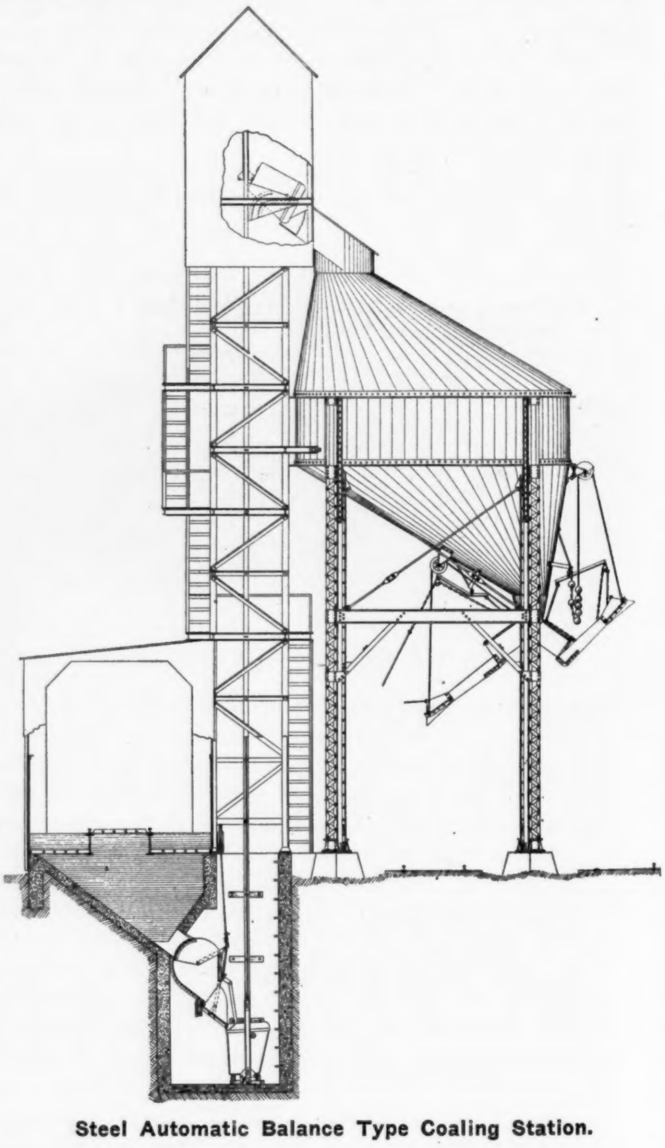
The generator used is the Crocker-Wheeler type, 6½ k. w., 125 volt, 52 ampere, 1,000 r. p. m. The gasolene tank will store 15 gals., sufficient for a day's work. The car runs on track at a speed of from 10 to 40 miles an hour, forward and reverse. A portable turntable with extension rails is provided to move the car to a siding when a clear track is required. This turntable consists of two spare rails, 8 ft. long, and four screw jacks, one under each corner of the car, which are all operated at once by bevel gears by power from the shaft. At the side of each jack at right angles to the track are 10-in. wheels, curved to fit the rails. The car is quickly lowered to the short rails and pushed to the adjacent track or edge of the road.

These cars have been supplied to the Chicago, Rock Island & Pacific and the Pittsburgh & Lake Erie, on which they are used for screw spike work. The Otto Company says that actual tests by the chief engineers of the above-mentioned roads have shown that two men with one electric driver can drive the screws as fast as three men using electric tools can drill the holes. From one and three-quarters to two seconds only are required to drive a spike with an electrical driver as against eight to ten minutes to drive a spike by hand.

The Otto tool car may also be used to operate hoists or vacuum cleaners; for operating lighting apparatus in cases where night work is required for repairs or clearing away wreckage; or for running air compressors which operate riveting hammers or sand blast work. It enables the crew to cover larger sections of track, thus effecting a considerable saving in labor expense.

A STEEL AUTOMATIC BALANCE BUCKET TYPE COALING STATION.

In developing its special line, the Ogle Construction Company, Chicago, has designed an all-steel, fireproof, automatic locomotive coaling station. There is on exhibition at that company's space in the Annex a complete working model of this station, showing the structure and machinery in detail. The model is an exact reproduction



Steel Automatic Balance Type Coaling Station.

of a 200-ton coal chute, with the hoisting machine, buckets and loaders, all reduced to one-eighth full size. The chute is in regular operation, and its demonstration is as satisfactory as a full-size structure.

The main storage bin is in circular tank form, giving it a neat appearance, and at the same time making it an ideal bin for storing coal. The main structure is supported on four lattice columns, with a conical-shaped bottom and top. The object of the cone bottom is to direct all the coal to one point, so that in taking coal the entire volume is

moved each time. Another point is that one or two spouts can be attached to serve that number of tracks without changing the design.

The hopper is located at one side of the main structure, and it can be varied in size or the track elevated to suit the conditions. It can also be housed over in cold climates for protection. The coal is delivered to the hopper track by a locomotive; from there to and from the hopper by the hoisting machine, which is provided with a winch head. After the coal is delivered into the hopper the automatic loaders, which as a rule are in pairs, cut off and deliver a bucket of coal at each trip. The weight of the bucket on the downward movement operates the loaders, one to a filling position, the other to a discharging position, the operation being repeated at each trip.

The hoisting machine is very complete and automatic in all respects. When the bucket reaches the top of the chute and is emptied, the hoisting drum stops, and remains so until the other bucket is loaded, and the hoist automatically reverses itself to elevate the loaded bucket. The hoist is also provided with an automatic lock to prevent a loaded bucket from falling in case of a power failure or an accident.

The apron used for the delivery of coal from the chute to the locomotive is an improvement over the old style, as it is provided with several very essential features, as follows: The cut-off gate is pivoted and closes by gravity; the apron is pivoted, so it has a lateral movement of 7½ ft., making it possible to coal a large locomotive at one spotting; the apron is provided with a breaking joint to prevent serious damage in case the engine moves while taking coal. The spout being perfectly balanced, it is easy to handle, and the valve being equipped with a peculiar compound leverage, to which the pull-rope is attached, the operator can use his own pleasure as to position while taking coal. The lower end of the apron being provided with a deflecting plate, all the coal is delivered to the locomotive, saving the expense of gathering up spilled coal on the ground.

The chutes are built in capacities from 150 to 500 tons, with elevating capacities of 50 to 100 tons per hour, and can be adapted to almost any condition.

A VALUABLE ACCESSORY TO THE BLUE PRINT ROOM.

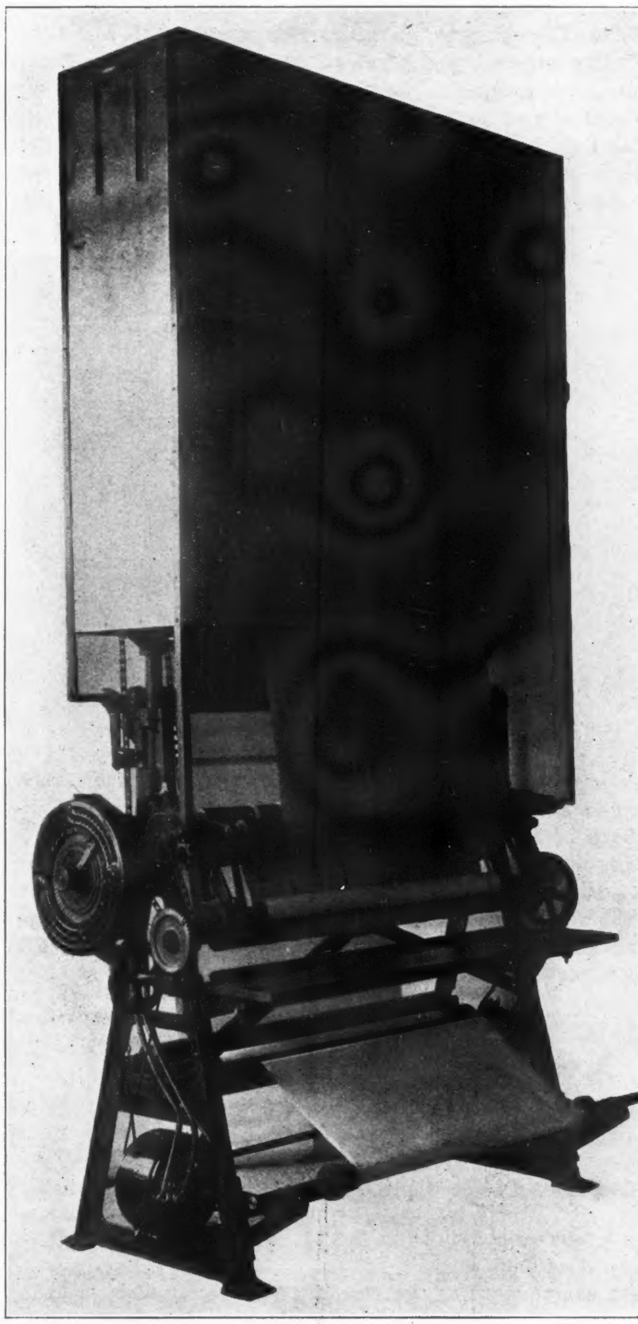
The problem of always having a supply of freshly sensitized paper on hand is one that has caused considerable annoyance to large makers of blue prints. Up to this time, blue print paper coating machines have been large and cumbersome, covering a large amount of floor space and turning out a product far in excess of any one company's requirements, and it has not been practical for the railway engineering departments and manufacturers to coat their own paper.

The C. F. Pease Company, Chicago, is showing, this year, at the Coliseum, a blue print paper coating machine, unique in design, which is thoroughly practical for the large user of blue print paper.

This machine occupies a space of only 3 ft. x 5½ ft. and can be set up against the wall. It is so simple in construction that it can be operated by the same man who operates the blue print equipment and at the same time. The apparatus is entirely self-contained, and is operated by a quarter horsepower variable speed motor, controlled by an electric speed changing device, so that any speed can be instantly secured, according to the quality and thickness of the paper that is being coated.

A roll of uncoated paper weighing 150 lbs. is placed on the receiving spindle. The paper is then carried under the rubber covered coating roller, up through the drying oven, which may be heated either by gas, electricity or steam, after which the sensitized paper is automatically wound up in a tight roll and in any length desired. An automatic measuring device is used, which is so arranged that just before the desired length of paper is reached a bell is struck, notifying the operator in time for him to cut off the paper and start a new roll.

With this apparatus it is possible for the operator, within twenty minutes after the machine is started, to have a fresh roll of paper ready for printing, and every fifteen or twenty minutes thereafter as long as the machine is in operation.



C. F. Pease Machine for Sensitizing Blue Print Paper.

The maximum capacity is twenty-five to thirty 50-yard rolls of paper per day.

The cut herewith illustrates the machine in question, arranged with a gas heated drying oven. The manufacturers claim that the cost of drying by gas does not exceed 5 cents per hour, while the cost of operating the quarter horse-power motor is nominal.

They are prepared to furnish the white paper in large rolls of any quality, also the coating chemicals, ready mixed in dry form in air-tight cans, so that all that is necessary for the

operator to do is to open the can and dissolve the contents in water. This solution will keep indefinitely.

FAIRBANKS-MORSE NO. 32 SECTION MOTOR CAR.

The latest development in gasolene motor cars for section work by Fairbanks, Morse & Co. is a car styled the "No. 32." It is on exhibition at their space in the Coliseum. On account of its lack of the usual many moving parts found on gasoline cars and engines it is styled "the simplicity car."

The engine is two cylinder, two cycle, air-cooled, direct connected to the rear axle of the car, the crank shaft and rear axle being integral, and of nickel steel construction. There are only five moving parts, viz., two pistons, two connecting rods and the crank shaft, and there are no valves, cams, pawls, sprockets or chain. Lubrication is automatic, the gasolene and oil being mixed before placing in the gasolene tank. As the two cycle engine takes the charge first into the

Fairbanks-Morse No. 32 Gasolene Motor Car.

crank case and then into the cylinder, the method of lubrication is thorough and positive as well as having the advantages of insurance against running out of oil, which cannot happen as long as there is gasolene in the tank. The frame is all-steel with a special steel yoke suspension for the engine, so arranged that no weight of the car can come in the center of the crank shaft and cause a possible deflection there, if the car is overloaded. The speed is from

Removable Power Plant Unit of the "Simplicity" Car.

6 to 25 miles per hour, and the car will run equally well in either direction.

As a complement to the No. 32 car, there is also on exhibition a sectionalized engine with which the car is equipped, operated by a small electric motor, so that the working parts of a two cycle engine and the manner in which the gasolene mixture is handled can be plainly seen.

The No. 32 has all the essential features necessary in a motor car for section work where the men in charge of them are not well posted on mechanics. It is now an acknowledged fact that the section motor car presents a great opportunity for economy in railway maintenance, and the only question is to get a reliable car, light enough to be easily handled off and on the track, simple enough for successful handling by the foreman and durable enough to stand up to the work required of it, with a minimum expense for upkeep.

THE SAUERMAN COALING STATION.

The Roberts & Schaefer Company, engineers and contractors, Chicago, the original promoter of the Holmen balanced bucket locomotive coaling station, has this year brought out a new plant which is particularly simple in operation and is known as the "Sauerman single unit coaling station." A general view and several details of the bucket operation are herewith illustrated, and a large view of the plant is exhibited in the company's booths at the Railway Appliances Exhibition.

The particular feature of the Sauerman coaling station is the simplicity of the plant and the rugged construction of the machinery. Some of the advantages over other types of plants are as follows:

First, it omits entirely a measuring feeder of any type

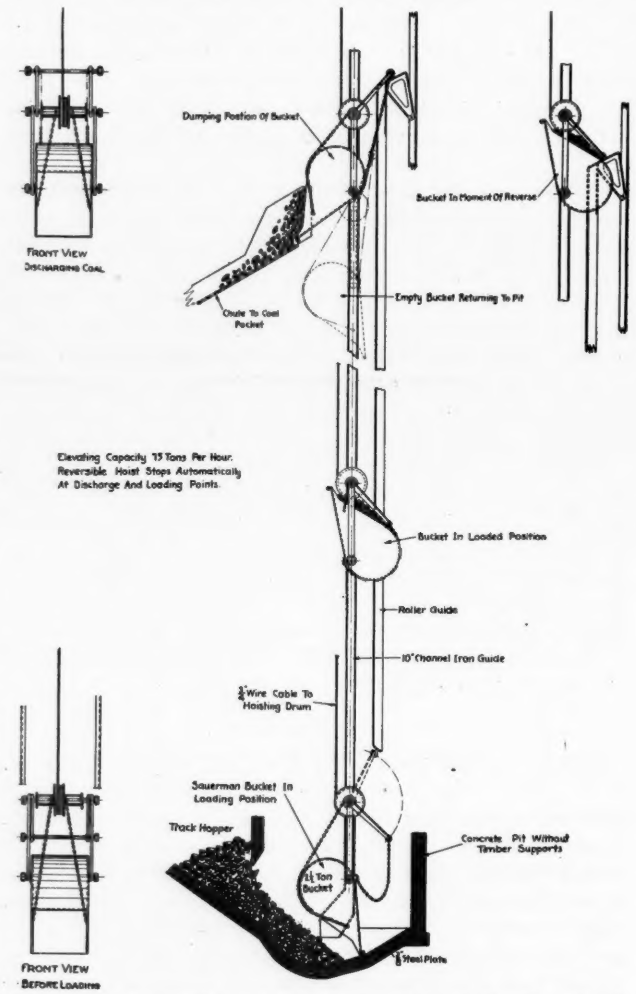
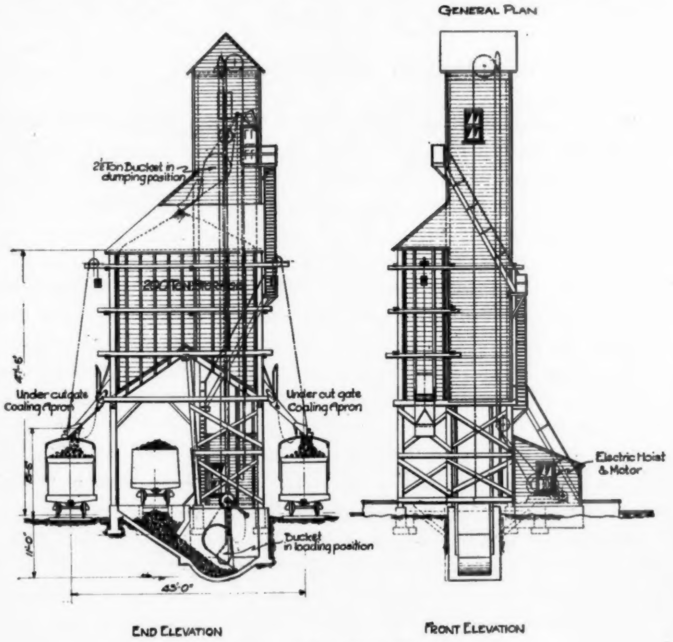


Diagram of Operation of Sauerman Patent Coaling Bucket.

in the bucket pit. Second, the bucket pit is only 11 ft. below the surface of the ground, while other style bucket pits range from 18 to 25 ft. in depth, necessitating the handling of water which usually accumulates in deep pits. Third, the design of the bucket requires only a single unit instead of bucket and feeder. There is no opportunity for spilling coal in loading the bucket, or of getting this coal under the bucket or feeder, as coal is in the pit at all times. The loaded bucket may ascend and reverse and descend to the pit with load, without receiving two buckets full of coal in the pit.

Fourth, the bucket hoist stops automatically at the top, preventing any possibility of overwinding into the sheaves. The hoist always stops automatically when the bucket is in loading position. There is no delay in loading and discharging the bucket, and there are no restricted openings

which prevent handling of large coal. The Sauerman plant eliminates all timber and machinery supports in the bucket pit and track hopper. The entire pit is concrete, with three steel rails at the bottom of the bucket well, and the elevating capacity is 75 to 150 tons per hour. On account of the shallow pit much less concrete is required for



Sauerman Coaling Station.

foundations. With the Sauerman bucket the coal is not dropped at the discharge point, breaking it into slack, but it slides out of the bucket and at the same time the bucket is completely turned over, preventing any wet slack from sticking to it.

PURIFIED WATER SUPPLY.

The Norfolk & Western formerly found it necessary to shop its yard engines at Columbus, Ohio, two or three times each week for recaulking the flues. In 1904 a water softener was installed at that point and, following the use of purified water and the removal of old scale deposits from the boilers, the yard engines were able to remain indefinitely at work. This initial installation has been followed by about 30 more, two of which were at points where the company wanted the service for only six months or until a naturally pure water supply became available, knowing that in the six months the softeners would save more than their total cost at those two water stations.

Another railway with experience in locomotive service insurance is the Florida East Coast, its experience having the advantage of being expressed in figures compiled for its annual report. This railway, with an equipment of water purifiers for only a portion of its water stations, increased its locomotive mileage from 30,000 miles to more than 50,000 miles between shoppings for boiler troubles. Mileage per ton of coal was increased from 20.2 miles to 20.5 miles, allowing a saving of 1,565 tons of coal per year. In one year the average freight train was increased from 14.7 cars to 20.5, while the fuel cost dropped from 0.1818 cents to 0.1570 cents per mile, with no change in price of coal. In one shop alone the force of boiler makers on repair work necessitated by water conditions was reduced from 12 men to four, and all overtime work, which had previously been very heavy, was entirely eliminated, making a saving of more than $10,000 a year in labor for boiler repairs. As many as three boiler failures in one day, and on the same train, frequently occurred formerly, but after the use of purified water these failures were reduced to a negligible number, and deadhead locomotive mileage was reduced to a minimum.

The installations mentioned were made by the American Water Softener Company, Philadelphia, Pa. Many other railways in addition to these have had water softeners installed by that company.

AN OLD SELLERS TIE-PLATE.

The Sellers Manufacturing Company, Chicago, is exhibiting at the Coliseum a Sellers anchor bottom tie-plate and a tie, which have recently been taken out of track after 10½ years' continuous service on a 4-deg. curve in the main line of a northern road handling a heavy iron ore and lumber traffic. The accompanying photograph shows a view of this tie-plate, together with a portion of the tie showing the imprint of the plate in the tie, indicating clearly that the plate had not moved from its original position in this period of service, and that there was no deterioration of the tie under the plate, or of the plate itself. This was an

Tie Plate and Tie After 10½ Years' Service in Heavy Traffic Main Line.

untreated cedar tie, cut locally. The plate was made according to standards in use at that time, and was about one-fourth of an inch thick. By a comparison with similar plates rolled to-day, it will be noted that on the later plates the corrugations have been increased to secure greater holding power, and that the newer plates have a shoulder. Otherwise the design is the same as that used by the Sellers Company to-day. This plate was made of wrought iron, which is still being used for the purpose by this company.

FROGS AND JOINTS.

The frog exhibit of the Pennsylvania Steel Company, Steelton, Pa., contains several designs not heretofore displayed by this company. In addition to the design 160 Manard Anvil Face frog, which has been on the market for a number of years, the company shows a solid Manard frog, design 167, furnished with integral base plate and cast to as near a uniform section as can be obtained without sacrificing the strength and durability of the frog; and also a Manard Anvil Face frog, design 169, with the Manard center so cored as to reduce, as much as possible, the cost of the special Manard steel. The point of the frog is part of the Manard center and the heel block runs back between the heel rails and furnishes support to the wheel tread until it strikes the full head of the carbon rail.

The Manard crossing shows a new type of joint. This joint is composed of rails that bind the abutting ends of the manganese castings and are held together by the Never Turn bolt. This bolt fits both the head and the flange of the rail, which feature eliminates the danger of the bolts

turning when the nuts are kept tight. These bolts require very little attention, as the split at the end is opened sufficiently to hold the nut in position.

DURABLE FLOORS FOR SHOPS AND FREIGHT HOUSES.

The difficulties with wood, concrete and other types of floors for railway freight houses and shops have led to the quite extensive use of asphalt floors for these purposes. The accompanying photograph shows the car shop floors of the Canadian Pacific at Winnipeg, Man., laid with asphalt mastic.

The use of asphalt for paving purposes is well known. It has also been used with success for floor construction both in this country and abroad. It is a noteworthy fact that when the proper material is used and the asphalt floor is properly constructed, it approaches very closely to the ideal surface for heavy traffic, but it is also noticeable that when inferior material is used or when the material is not handled properly, the floor comes far from living up to expectations. However, when the material is able to withstand a wide range of temperature without being either too brittle in winter or too soft in summer, the floor can

Asphalt Mastic Floors in Canadian Pacific Car Shops, Winnipeg.

be given a hard finish and still retain the elasticity that makes it so durable and pleasant to work upon.

One distinct advantage of the asphalt floor lies in the entire adaptability for resurfacing worn out concrete or wood floor. It requires only in the latter case that the supports should be sound. The advantages of the asphalt are shown by its very frequent use as a material for repairing and filling holes in worn concrete floors, something which cannot be satisfactorily done with cement, but the asphalt is adhesive and wears much better than the surrounding concrete.

The manner of laying the floor is very simple. The mastic material comes in blocks weighing 80 lbs. each. These are broken up, melted with flux in a kettle, the dry grit, consisting of torpedo gravel or granite or limestone screenings, is then added and the whole mixed with stirring rods and brought to a temperature of 400 deg. F., after which it is removed to the work in wood buckets to hold the heat.

While hot, the mastic is spread evenly and compacted so as to make a jointless surface of very dense material. For ordinarily heavy traffic 1½ in. thickness is sufficient, while for loading docks, driveways or floors subject to the heaviest trucking, 2 in. is better.

The material is laid in 2-ply with lapped joints and the finished surface presents the same appearance as concrete. The purity and elasticity of the asphaltic matrix and flux used, together with care in the mixing and proportioning of the mineral aggregate, determine the character of the completed floor.

The satisfaction resulting from extensive use of asphalt floors to withstand water, as in breweries, trucking, as in packing houses and warehouses, and the heavy service conditions in shops has demonstrated its suitability as a wearing surface.

STRAUSS BASCULE BRIDGE.

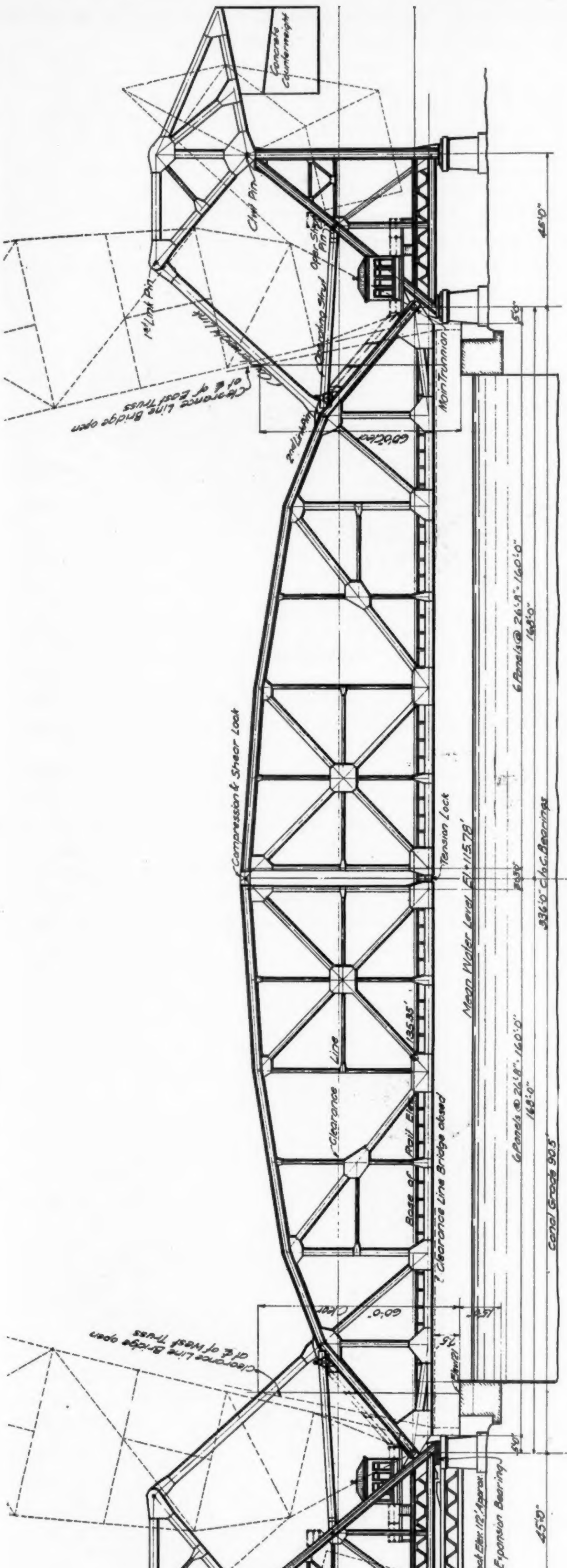
The development of the Strauss bascule bridge has been continued during the past year, and several unusual designs have been worked out, including those for the Sault Ste. Marie bridge of the Canadian Pacific, the longest double-leaf bascule bridge designed up to this time; the Calumet river bridge, at South Chicago, for the Baltimore & Ohio, the longest single-leaf bascule; the Kaministiquia river bridge for the Canadian Pacific, at Ft. William, the first double-deck bascule; and the Portage river bridge at Port Clinton, Ohio, on the Lake Shore & Michigan Southern, the first four-track bascule bridge, the first two of which structures are illustrated in the accompanying drawings.

The Calumet river bridge, for the Baltimore & Ohio, at South Chicago consists of a 50-ft. tower span and a 235-ft. movable span, both riveted throughout. The latter span deviates only slightly from a stationary span of the same dimensions. The trusses are supported directly on the two river piers, and the floor system and top and bottom lateral bracing are identical with those for the ordinary span, with the exception that the end portal at the trunnion end of the bridge is made especially heavy to carry the operating machinery, which is located at this point. In later designs, however, the operating machinery is located on the tower, gaining a considerable advantage.

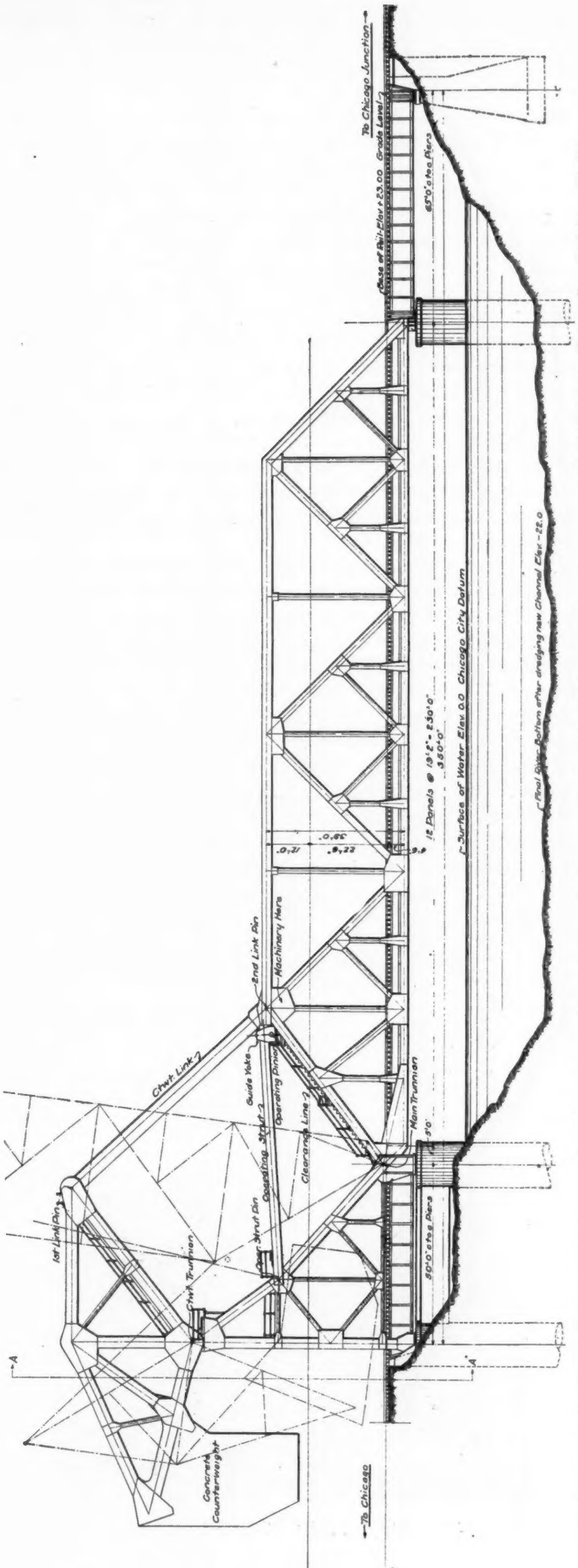
This bridge is similar in detail to the twenty or more heel trunnion bridges which have been built or are now under construction and which vary in length from 108 ft. to this 230-ft. span. This type is identical in principle with the old time, simple trunnion bridge, with the exception that the main trunnion is placed directly on top of the pier and that the tail ends of the trusses and the counterweight, which, with this location of the trunnion, would obstruct traffic in the ordinary trunnion bridge, have been cut loose, so to speak, from the front part of the trusses and mounted separately on trunnions at the top of a low tower, being so connected with the movable span by means of a structural steel link that the angular movement of the counterweight is the same as that of the leaf, and the counterweight action is, therefore, not disturbed.

This separation of the counterweight part from the main span reduces the dead load reactions on the piers and makes the design flexible in that the counterweight may be placed underneath or overhead at will. This flexibility is further attested to by two structures now in course of construction, which, although unusual, embody precisely the same elements as the Baltimore & Ohio bridge. One of these bridges is the double-track single-leaf bridge over the Kaministiquia river for the Canadian Pacific, which, in addition to a double-track railway, carries a highway 29 ft. wide on an upper deck. The second is a four-track structure for the Lake Shore & Michigan Southern over the Portage river at Port Clinton, Ohio, which follows the ordinary design of the heel trunnion type for the center pair of tracks, while the outer tracks are carried on floor beams extending from the bascule trusses to outer plate girders. These plate girders are supported by a heavy cross girder at each end of the span when the bridge opens, but come to rest on the piers when the bridge is closed.

The Baltimore & Ohio bridge is being built under the direction of J. E. Greiner, consulting engineer, who also pre-



Strauss Bascule Bridge of the Canadian Pacific at Sault Ste. Marie, the Longest Double-Leaf Bascule Bridge Built.



Strauss Bascule Bridge of the Baltimore & Ohio Over the Calumet River at South Chicago, the Longest Single-Leaf Bascule Bridge Built.

pared the plans for the substructure. The Foundation Company of New York is building the substructure, while the Pennsylvania Steel Company has the contract for the fabrication and erection of the superstructure.

The single-track bascule bridge for the Canadian Pacific, over the United States ship canal at Sault Ste. Marie, Mich., the plans for which have just been completed, has a span of 336 ft. center to center of channel piers. This structure gives a single unobstructed channel wider than that provided by the longest existing swing bridge. Each half of the bridge conforms in a general way to the standard type of Strauss heel trunnion bridge, and consists of a 168-ft. river arm and a 45-ft. tower carrying the counterweight. Instead of acting as a cantilever for live load, as is ordinarily the case with double-leaf bascule bridges, the two river arms or leaves are so locked together in the center when the bridge is closed that the two halves of the trusses act as one single truss from pier to pier.

The counterweight device on this Sault Ste. Marie bridge is arranged similarly to the Baltimore & Ohio bridge, the dead load reactions on the piers in both cases being vertical and constant.

The locking of the trusses in the center is automatic and is accomplished without the use of movable parts of any kind. The tension hinge in the bottom chord is similar to the ordinary railway coupling, while the top hinge is an adaptation of the common center hinge of a three-hinge arch bridge and transmits both compression and shear. The difficulty which has confronted designers attempting to design a "simple span" bascule, viz., the expansion due to temperature variations, has been overcome by mounting one of the counterweight towers on friction rollers so that when the bridge is closed one end is free to expand as in an ordinary stationary bridge. This type of bridge was adopted by C. N. Monsarrat, then bridge engineer of the Canadian Pacific, who has since been succeeded by P. B. Motley, engineer of bridges.

TWO TANKS AT ONE LOCATION.

The accompanying illustration shows the tanks built at McCook, Neb., by the Chicago Bridge & Iron Works, Chicago, for the Chicago, Burlington & Quincy. It was desired here to have two tanks at one location instead of one larger structure so that, if it became desirable for any reason, one

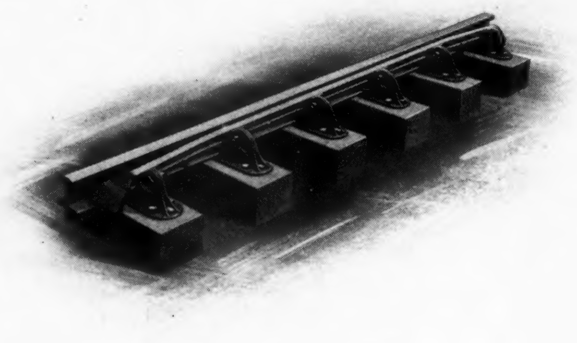
Two Steel Tanks at One Location.

tank could be emptied without interrupting the locomotive water service.

The tanks shown, instead of being provided with cast iron inlet pipes with wood frost boxing, have large riveted steel riser pipes or mud drums which are made of sufficient diameter to prevent interruption of service from freezing. These mud drums also act as settling basins and have blow-off valves at the bottom so as to make the tank practically self-cleaning. Steel tanks are especially attractive at the present time because of the low price of metal.

A NEW GUARD RAIL.

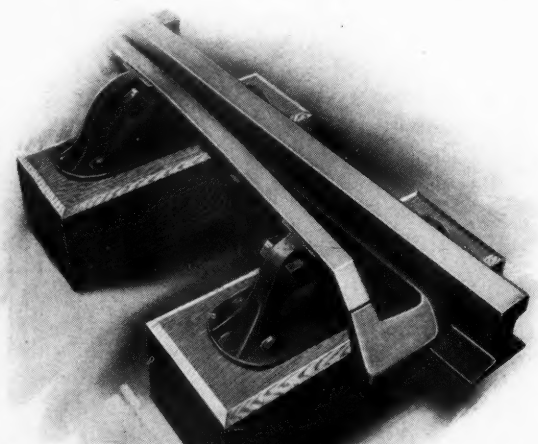
The possibility of greater efficiency and more economy in the design and use of guard rails has been receiving considerable attention from railway engineers in the last two or three years. The accompanying illustration shows a new type of guard-rail construction. While manganese steel has been in use for several years for guard-rail purposes, it has



A New Guard Rail.

hitherto been either as a strip bolted or riveted along an ordinary bent T rail, or else the entire guard rail has been a single manganese casting.

In this type an angular-shaped manganese guard rail, 10 ft. long, is rigidly carried or seated in malleable chair plates, which are formed of single castings passing beneath the running rail. In actual practice it has been found that this guard rail is far more rigid than the ordinary rail guard, and requires little or no attention when once placed in position. The length of 10 ft. permits of long curved flare ends, giving easy entry for the wheels.



A New Guard Rail.

Only the actual part of the guard in contact with the wheels is of manganese steel. The brace plates, being of malleable iron, permit of an economical construction, and, as the guard rail proper can easily be replaced without in any way disturbing the chairs, the economy of this design may readily be seen. The device has just been placed on the market by the Morden Frog and Crossing Works, and may be seen at their exhibit in the First Regiment Armory.